Serfojee Rajah 1827

THE

REPERTORY

OF

ARTS AND MANUFACTURES:

CONSISTING OF

ORIGINAL COMMUNICATIONS,

SPECIFICATIONS OF PATENT INVENTIONS,

AND

SELECTIONS OF USEFUL PRACTICAL PAPERS

FROM THE

TRANSACTIONS

OF THE

PHILOSOPHICAL SOCIETIES

OF ALL NATIONS, &c. &c.

VOL. V.

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CONTENTS

OF THE

FIFTH VOLUME.

Page

I. Specification of Mr. Burgess's Patent for a Method of producing a rotary Motion from the Action of an alternate Movement, &c. — 1

II. Specification of Mr. Green's Patent for constructing navigable Canals, without the Use or Necessity of Locks, &c. — — 11

III. Specification of Mr. Cheston's Patent for making elastic spring-Buckles, and Spurs, in Gold, Silver, &c. — — — 19

IV. Specification of Mr. Emerson's Patent for making Brass with Copper and Spelter, — 24

V. Description of an improved Printing-Press; invented by Mr. Joseph Ridley, — — 26

VI. Description of a self-moving or sentinel Register; invented by Mr. William Henry, — 32

Page

VII. Account of a Machine for pumping Veſſels at Sea, without the Labour of Men. By Mr. RICHARD WELLS, — — — 38

VIII. Experiments and Obſervations to inveſtigate the Nature of a Kind of Steel called *Wootz*, &c. By GEORGE PEARSON, M. D. — 45

IX. Obſervations on the Uſe of Sithes for reaping Corn, &c. publiſhed by the Patriotic Society of Milan. 62

X. Specification of Mr. MATHEW's Patent for completely ſeparating the Beer from Yeaſt, and preſerving the Yeaſt, — — — 73

XI. Specification of Mr. SPARROW's Patent for raiſing, removing, and delivering Earth, Water, Stones, &c. — — 77

XII. Specification of Mr. ATKINSON's Patent for making certain Colours, of a ſuperior Quality to thoſe hitherto made from the ſame Materials, 89

XIII. Specification of Mr. GOLDING's Patent for dying, ſtaining, and colouring, Beaver and Beaver Hats, Green, or any other Colour, — 98

XIV. On forming Oak-Trees into Compaſs-Shapes, for the Uſe of Ship-Builders. By Mr. WILLIAM RANDALL, — — 101

XV. Concluſion of Dr. PEARSON's Experiments and Obſervations on a Kind of Steel called *Wootz*, 107

XVI. On the Purification of crude Saltpetre. By M. BAUME', — — — 129

XVII. On preſerving thoſe who grind Colours from the Diſorders occaſioned thereby. By M. BOULARD, — — — 138

XVIII. Specification of Mr. NICHOLSON's Patent for a Machine for printing on Paper, Linen, Cotton, Woollen, &c. — — 145

Page

XIX. Specification of Mr. BLUNT's Patent for a new-invented Composition to be used instead of Yeast, — — — 171

XX. Specification of Mr. GRIMSHAW's Patent for certain vegetable Substances, to be used in clearing or bleaching printed, painted, stained, or dyed Cloths, &c. — — 173

XXI. Specification of Mr. WORTH's Patent for a Preparation or Cement for preserving Ships from Worms, and for various Purposes in Agriculture and Commerce, — — 177

XXII. Description of a Machine for cutting Files. By B. O. — — — 179

XXIII. On the Conversion of animal Substances into a fatty Matter much resembling Spermaceti. By GEORGE SMITH GIBBES, B. A. — 185

XXIV. Conclusion of M. BAUME's Memoir on the Purification of crude Saltpetre, — 196

XXV. On the Action of Fluor-acid upon siliceous Earth, and on the Application of that Property to engraving upon Glass. By M. de PUYMAURIN, 210

XXVI. Specification of Mr. BRAHAM's Patent for Locks upon a new Construction, — 217

XXVII. Specification of Mr. BIRNIE's Patent for preparing and restoring the Calk of Lead, after being used in extracting the mineral Alkali from common Salt, — — 233

XXVIII. Specification of Mr. BUCHANAN's Patent for a Pump for raising Water in various Situations, particularly on-board Ships, &c. — 236

XXIX. Specification of Mr. DEARMAN's Patent for making Mills for grinding Malt, and various other Articles, — — — 247

Page
XXX. Description of a Method of preventing Injury to the Workmen employed in preparing White Lead. By Mr. ARCHER WARD, — 249
XXXI. Experiments on the alkaline Substances used in bleaching, and on the Colouring-Matter of Linen-Yarn. By RICHARD KIRWAN, Esq. 255
XXXII. Conclusion of M. de PUYMAURIN's Memoir on the Action of the Fluor-acid upon siliceous Earth, &c. — — — 271
XXXIII. Specification of Mr. PEPPER's patent for a Kiln for drying Malt, or other Grain, 289
XXXIV. Specification of Mr. BENTHAM's Patent for a new Method of planing Wood, — 293
XXXV. Specification of Lord WILLIAM MURRAY's Patent for extracting Starch from Horse-Chesnuts, — — — 318
XXXVI. Specification of Mr. BAYLEY's Patent for making fresh Water from Sea-Water, or from Brine-Springs, &c. — — 320
XXXVII. Description of a Loom on a new Construction. By Mr. SAMUEL SHOLL, — — 322
XXXVIII. On welding Cast Steel. By Sir THOMAS FRANKLAND, Bart. — — 327
XXXIX. Continuation of Mr. KIRWAN's Experiments on the alkaline Substances used in bleaching, &c. — — — 330
XL. On the Means of making Bread from Rice alone, 350
XLI. Description of a movable Table, for the Use of Engravers. By the Abbé JOSEPH LONGHI, 354
XLII. Specification of Mr. BURDON's Patent for Cast-Iron Blocks, to be used in the Construction of Arches, — — — 361
To this is added an Account of Wearmouth-Bridge.

Page

XLIII. Specification of Mr. CARPENTER's Patent for bleaching Paper in the Water-Leaf or Sheet, and sizing it, without drying, — 369

XLIV. Specification of Mr. STUARD's Patent for an Anchor on a new Construction, — 380

XLV. Specification of Mr. LEVY's Patent for making Semolina from Wheat, — — 383

XLVI. Observations on the raising and dressing of Hemp; by EDWARD ANTILL, Esq. — 384

XLVII. Conclusion of Mr. KIRWAN's Experiments on the Alkaline Substances used in bleaching, &c. 396

XLVIII. On the comparative Intensity of the Heat produced by Charcoal, and charred Turf; by M. Sage, — — 418

XLIX. On watering Kitchen-Gardens &c. upon a large Scale; by M. SYLVESTRE, — 423

PLATES

PLATES

IN THE

FIFTH VOLUME.

	Page
1. Method of producing a rotary Motion from an alternate Movement, — —	10
2. Improved Printing-Prefs, — —	31
3. Self-moving or fentinel Regifter, and Machine for pumping Veffels at Sea, — —	44
4. Sithes for reaping Corn &c. — —	72
5. Machine for raifing, removing, and delivering Earth, Water, Stones, &c. — —	88
6. Method of forming Oaks into Compafs-Shapes,	106
7. Contrivance for preferving thofe who grind Colours from Diforders, — —	144
8, 9, 10. Machine for printing on Paper, Linen, &c.	170
11. Machine for cutting Files, — —	184
12 and 13. Locks upon a new Conftruction, —	232
14. Pump for raifing Water, &c — —	245
15. Method of preventing Injury to thofe who prepare White Lead, — —	254
16 and 17. Kiln for drying Malt, or other Grain,	292
18. Loom on a new Conftruction, — —	326
19. Movable Table, for the Ufe of Engravers,	360
20. Caft-Iron Blocks to be ufed in Arches, —	364
21. View of Wearmouth-Bridge, —	368
22. Anchor on a new Conftruction, — —	382
23. Manner of watering Kitchen-Gardens, &c.	432

REPERTORY
OF
ARTS AND MANUFACTURES.
NUMBER XXV.

I. *Specification of the Patent granted to* THOMAS BURGESS, *of Weymouth-ſtreet, Portland-place, in the County of Middleſex, Eſq. for a Method whereby to produce a rotary Motion from the Action of an alternate Movement, in any Direction, effected by a Steam-Engine, or any other Machine.*

WITH A PLATE.

Dated June 9, 1789.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, AND THESE PRESENT WITNESS, that in compliance with the terms of the ſaid laſt mentioned proviſo, in that behalf ex-

 preſſed,

preſſed, I the ſaid Thomas Burgeſs have particularly deſcribed and aſcertained, and by theſe preſents do particularly deſcribe and aſcertain, the nature of my ſaid invention, and in what manner the ſame is to be performed, in manner following; that is to ſay, the rotary motion produced from the action of an alternate movement, by the method of my invention, and according to the new principle which I have adopted, is brought about by means of an axis, and a moving collar thereupon, with a pall, palls, or catches, affixed thereto, or connected therewith, and a counterpoiſe acting on the ſame; which apparatus I have invented and put together. The annexed drawing, in perſpective, (ſee Pl. I. Fig. 1.) exhibits an external view of the mechaniſm of my invention, when the alternate movement is effected by a ſteam-engine; where C refers to the collar, upon an axis which receives the rotary motion. The reſt of the perſpective drawing ſerves to ſhew, by way of example, how the apparatus of my invention appears externally, when connected and worked with the lever of a ſteam-engine, *viz.* A the axis; C the ſaid collar; R the chain, rope, or other flexible ſubſtance, applied round or upon

upon the collar, and connected with the moving power and counterpoiſe; W the weight or counterpoiſe; F the fly. And, for performing my method of rotary motion, when it is to be effected by means of any other machine or moving power than a ſteam-engine, I diverſify the conſtruction and application of my apparatus, in ſome ſmall degree, according to the ſort of machine, mechaniſm, or acting power, by which the firſt action thereon is to be effected; nevertheleſs, the operation always partakes of, and is comprehended within, the ſame method and principle. I now proceed to explain the internal conſtruction of my apparatus, as ſuited to this example; and the profile drawing therefore ſerves to ſhew the inſide of the ſame apparatus; (which is only externally viewed in the perſpective;) in which profile the inſide of the ſaid collar C is repreſented, and a pall or catch marked P is alſo repreſented, which moves upon a fixed pin, by which it is hung in a groove or cavity made for its reception in the ſaid collar; and, in the ſaid profile, are repreſented teeth or notches in the ſaid axis. In the working of the machinery, the ſaid pall or catch falls, by its own gravity, into the

ſaid teeth or notches in the ſaid axis, when acted upon by the moving power, forcing the axis forwards, together and in union with the collar, and then the pall drops and ſlides back over the teeth or notches, whilſt the collar is in the act of being drawn backwards by the ſaid counterpoiſe. In the perſpective and profile drawings, reſpectively, I have introduced the figures of the lever of a ſteam-engine, the better to ſhew to the eye how and whence my apparatus receives its action, according to that example; and I have introduced a fly upon the axis, to ſhew how and by what power the action is then continued. Thus the rotary motion produced by this method, invented by me upon the principle which I have adopted, being brought about by the action of an alternate movement, continues its conſtant and regular motion and progreſs forwards, notwithſtanding the collar is returned back to its proper place and poſition by the re-action of the counterpoiſe; and thereby the collar is prepared to receive each repetition of the ſtroke or impulſe of the firſt moving power, without impeding the rotary motion of the axis, which axis continues all along in the original rotary motion. In the purſuing

ſuing of this my method, and in the conſtruction of the apparatus and performing the operations of this invention, I ſometimes uſe a leather, or other flexible ligature, inſtead of a chain, or rope. The counterpoiſe may be effected by a ſpring, or worm, or by any way that will, by counterpoiſe and re-action, return the collar to receive the ſucceſſive action of the firſt moving power. And I farther add, for deſcribing and aſcertaining the nature of my ſaid invention, and the manner in which it is to be performed, the following particular remarks and obſervations: *viz.* Upon an axis, to which ſuch rotary motion is to be communicated for any purpoſe, a collar is accurately fitted, ſo as to turn freely thereupon, and ſo ſecured on each ſide as to prevent its ſliding; round which ſaid collar, a chain, rope, or other flexible ſubſtance, is wound or placed; one end whereof is carried and made faſt to the lever of a ſteam-engine, or to any other moving power which acts by alternative motion, whether perpendicularly, horizontally, or in any other direction; and by and upon the other end thereof a weight is ſuſpended; or a ſpring or ſprings, or other power, is

or

or are applied thereto, or to the collar, by ſome ſufficient means, according to the nature of the work; which weight, ſpring, or other power, muſt act as a counterpoiſe, to draw the collar back, in the interval between each ſtroke or impulſe of the moving power; and two or more ſuch chains, ropes, or other flexible ſubſtances, may be uſed to produce the ſame effect; each of them being, in ſuch caſe, fixed by one of the ends thereof to the ſaid collar, and the other ends, reſpectively, being aptly connected, one with the moving power, and the other with the counterpoiſe. And to give the effect intended, of turning the axis round by means of the collar ſo acted upon, the pall or catch, palls or catches, or other ſimilar contrivance, is or are placed within or upon, or otherwiſe connected with, the ſaid collar; in ſuch manner that one end or part of every ſuch pall, catch, or other contrivance, may, at each ſucceſſive impulſe of the moving power, moſt readily fall, or be preſſed into, and act upon, teeth or notches, which muſt be for that purpoſe cut in, or fixed upon, the axis; over which ſaid teeth or notches the ſaid palls, catches, or ſuch other

other contrivances, eaſily and freely ſlide back, when the collar is drawn backwards by the counterpoiſe. Thus, by the ſaid palls, catches, or ſuch other contrivances, upon the teeth or notches, (or by preſſure alone where the reſiſtance is but ſmall,) the axis is forced round with the collar by every alternate ſtroke of the moving power; but the palls, catches, or ſuch other contrivances, being diſengaged from the teeth or notches at the inſtant of ſuch ſtroke of the moving power being completed, the collar is then drawn backwards by the counterpoiſe, and ſo prepared to be acted upon again with the whole force of the moving power in conſtant ſucceſſion, as long as the moving power is at work; the motion of the axis being, during the whole time, continued forward equally and uninterruptedly, by means of a fly or flies thereto aptly annexed or applied, or otherwiſe, as may be found convenient. And the whole may be ſtopped or ſet in motion inſtantly, when the moving power, or counterpoiſe, is in any relative poſition, or at any point, either of the ſtroke or return of the alternate motion, without any jirk or ſhaking; which is a benefit not attained to in any of the methods heretofore em-

ployed

ployed for communicating a rotary from an alternate motion. If it ſhould, in any caſe, be found more convenient to employ an inflexible beam or rod to impel the collar, and therewith the axis, forward, this may be accompliſhed by indenting the rim of the ſaid collar, and alſo one ſide of ſuch beam or rod, with teeth or notches fitted to each other; in which caſe, the weight of ſuch beam or rod may itſelf be made to act as a ſufficient counterpoiſe to bring the collar back, ſo as to be duly acted upon by the next ſucceeding ſtroke; but, in general, a chain, or ſome flexible ſubſtance, applied according to the above deſcription, will anſwer beſt. The application of this rotary motion may be made, with the greateſt advantage, to the turning of any kind of millwork, for grinding, for rolling, for flatting, or ſlitting, any kinds of metal, and for all other purpoſes to which mills are or can be applied; alſo for working tilt-hammers, or ſtampers, in iron works; and for turning and boring of cannon; as well as for all ſmaller works upon ſimilar principles; and in ſhort, for every ſpecies of work and manufactory to which mill-work, turners inſtruments, or any form of rotary motion, is, or hath

hath been, or can be, applied. It would be endless to ſhew every different form of application in the way of example: but that example which I have given, by the drawing and references, ſerves to ſhew the true nature of my invention, and one of the moſt obvious manners in which it is to be performed. From that example, with the above illuſtration, and the whole of my deſcription, I conceive that my method, and the principle thereof, and apparatus adapted for producing the rotary motion, in the way ſpecified, from the action of an alternate movement, is aſcertained; and this my invention is to be uſed, as well in works of the greateſt magnitude, and requiring the mightieſt ſtrength, as in thoſe requiring only moderate ſtrength, and even down to the working a turner's lathe, or the moſt trivial implement. The certain advantages to the public, in this my method, will be found by the eaſe in the performance of it, and the effect it has in its operation: and by reaſon that the mechaniſm may be made and kept in repair at a comparatively ſmall expence, and is worked without any ſhaking or jirking, which is a merit not attained to in, or by means of, any

of the methods heretofore invented for commu-nicating a rotary motion from an alternate move-ment. In witneſs whereof, &c.

Explanation of the figures.

(See Plate I.)

Fig. 1, Perſpective.
A. The axis.
C. The collar.
F. The fly.
L. The lever.
R. The rope.
W. The weight.
The Pall is ſeen only in the profile.

Fig. 2, Profile.
The ſame letters refer to the ſame parts in both figures.

The ſide of the collar is here removed to ſhew the pall P, and its application to the teeth or notches in the axis.

Fig.1.

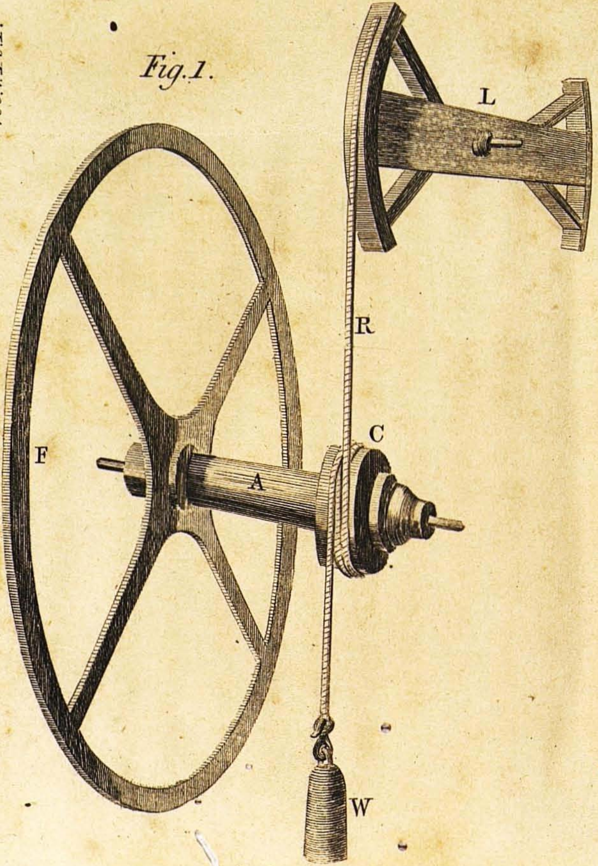
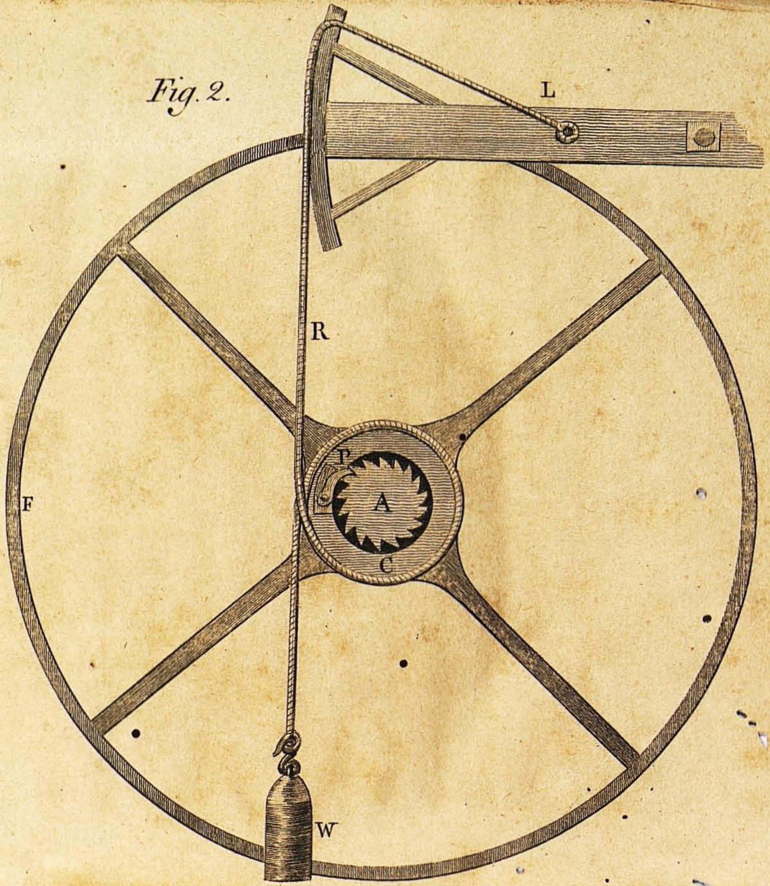


Fig.2.



II. *Specification of the Patent granted to Mr.* JOSHUA GREEN, *of the Pariſh of Ginſeley, in the County of York; for his Method of conſtructing navigable Canals, without the Uſe or Neceſſity of Locks, whereby moſt of the Objections to, and Inconveniencies ariſing from, Canals are effectually removed.*

Dated June 18, 1793.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE that, in compliance with the ſaid proviſo, I the ſaid Joſhua Green do hereby declare, that my ſaid invention is deſcribed in manner following; that is to ſay, the nature and method of my invention is by inclined plane, wheel, balance, veſſels, and levers, of a particular conſtruction. Firſt, Suppoſe a particular riſe, as for inſtance, about thirty feet, which is about equal to the riſe of four common locks; I propoſe to overcome that difficulty, without locks or loſs of water, by inclined planes, &c. Let two principal

ones be erected, of good ſtone or brick materials, eight or ten times the length of the perpendicular or angle of elevation, the longer the inclined planes the leſs ſtreſs will lie upon the ropes and other machinery hereafter deſcribed; but upon the ſaid inclined planes muſt be laid and fixed a frame of wood, ſuppoſe of half or quarter deal balks, and, to prevent friction as much as may be, the top ſide of ſaid wood ſhould be covered or ſhod with forged or caſt iron. A third inclined plane, about two thirds the length of the other, to be betwixt the other two aforementioned, for an uſe hereafter deſcribed. Secondly, The commercial boats I propoſe to be about thirty or thirty-five feet long, ſeven feet wide, and to draw betwixt four and five feet water, which I apprehend will contain about twenty tons of burden. One veſſel I propoſe to aſcend up one inclined plane, as the other deſcends upon carriages hereafter deſcribed; then it is ſuppoſed that one commercial boat draws up the other, excepting the friction, which will be eaſily overcome by the machinery hereafter deſcribed. Thirdly, I ſhall next deſcribe the carriages, or what I call cradles, to

contain

contain the ſaid commercial boats, which I conceive to be the moſt difficult part of the apparatus, and alſo the moſt ingenious. Then ſuppoſe four beams, or half deal balks, joined or framed together for the two ſides, of ſufficient width for the veſſels to ſlip in and out when in the water; on which account the ſaid frame or carriage is to be open at each end, joined together at the bottom by three or four croſs timbers, and good timber knees at each corner and joint, ſuch as boat-builders are accuſtomed to uſe. And, that the ſaid boat or veſſel may ride as eaſy as in water, when in the ſaid cradle, the bottom frame is to be corded, like a poor man's bed, with rope about inch diameter, and about one hundred and twenty yards long; the eyes or holes the ſaid rope paſſes through are to be eaſy, and as free from friction as poſſible, that the rope or cord may draw from end to end, then all parts of ſaid rope will have equal bearing: it is alſo meant that the ſaid cording is to be above the timbers that join the bottom part of ſaid cradles. Four or more ſtrong wheels, either of caſt metal, or ſtrong aſh plank, about four feet diameter, are to be added to this ſaid

ſaid cradle-frame; I think the latter, *viz.* aſh plank, is ſafer to truſt to, about nine inches thick at the centre, and about five inches thick at the rim or periphery, the ſole of which rim is to be ſhod with forged or caſt iron. Now comes the difficulty of axleing theſe wheels, conſiſtent with ſtrength and convenience; for, if the axletrees went over the veſſel, it would be inconvenient to the loading, as wool-packs, &c. and if under the veſſel, the burden being ſo much above the centre of gravity would endanger overſetting; alſo axles ſo long would require to be of enormous ſtrength; which difficulties to obviate, I propoſe what I call a falſe rung, beam, or half balk, of timber, well bolted and joined to the upright timbers of each of the outſides of the frame or cradle, but at ſuch diſtance from the ſaid outſide frames as will admit the wheels above deſcribed within the ſaid falſe rung; then each wheel will have its own axis of iron, about three inches diameter, and only eighteen inches long. I recommend that the axles be faſt in the wheels, and turn round with them, which I apprehend will cauſe the machine to move more ſteady. Fourthly, I ſhall next de-

ſcribe

fcribe the principal lever or regulating wheel, which I propofe to be twenty feet diameter, with fhort levers or hand-fpokes, fixed upon each fide of the periphery or fellies of faid wheel, three feet long, which will be equal to a lever of thirteen feet. The faid wheel will hang vertically, being well fixed on the middle or centre of a beam about thirty feet long, and fay about twenty inches diameter, which muft at each end, with its gudgeons, reft upon two ftrong frames of wood, elevated by their legs to a proper height on each fide of the upper canal, about thirty feet on the canal. And, if it be thougt too long betwixt the two extremities or fulcrums, other two fulcrums may be raifed on each fide of the vertical wheel; that part of the beam or axis moving upon thefe fulcrums being ribbed with fteel ribs, and moving upon braffes, after the manner of an old-fafhioned wind-mill. The ufe of this beam or axis is for two pair of ropes to wind or coil upon, faftened to the carriage or cradle of each boat, the one pair of ropes on the upper fide of the axis, and the other pair on the under fide; and, to keep the faid ropes parallel, one of the ropes of each pair muft

be

be ſo fixed by a ſcrew, or ſome other device, as that it can be eaſily lengthened or ſhortened. In my models I have tried with one rope, but could not make it anſwer ſo well as two; I alſo think two ſtronger than one, and ſafer to truſt to; I ſuppoſe the ropes, being made of the beſt hemp, need not be much above inch diameter. The uſe of the lever wheel is to regulate, by either aſſiſting and quickening the motion by the ſhort levers or hand-ſpokes; and, for retarding, a brake may be fixed upon the face or ſide of the ſaid wheel, after the manner of a windmill-brake. Fifthly, The third inclined plane, the uſe of which is to aſſiſt the veſſels going in and out of the upper canal; for, whatever the elevation propoſed to be raiſed at one operation be, four or five feet will be loſt in delivering the veſſel or boat into the upper canal; for, the aſcending veſſel, having arrived at the top of its inclined plane, is landed on to a flat, but rather inclined towards the upper canal, and, to get ſafely launched into the upper canal, it muſt deſcend down an inclined plane into the water at the upper canal; but, to prevent it deſcending too precipitately, a ſingle rope is fixed or hung to

the

the hind part of the cradle, the other end of ſaid rope being coiled and faſtened on an axis, on which axis or beam is fixed another lever wheel, but need not be ſo big as the other already deſcribed; from which axis alſo goes another rope, or couple of ropes, joined to a carriage or veſſel with four wheels, at the bottom of the third inclined plane; and, by its aſcent up ſaid third inclined plane, it ſuccours or lets down the commercial boat into the upper canal; and, by its deſcent down ſaid third inclined plane, it aſſiſts in getting a commercial veſſel out of the upper canal on to the head of its inclined plane; at the ſame time it is ſuppoſed that a commercial boat is coming out of the lower canal; in which lower canal there is no difficulty, for, the carriage or cradle being made ſpecifically heavier than water, the boat when let looſe will naturally float out of the carriage, either in the lower canal or upper, being made deeper of water at thoſe places for that purpoſe. It would be well to have a ſpare veſſel or two ready loaded with water, or any other materials, in caſe of an alternate courſe not being kept up by commercial boats. But a more

ſimple and cheap method (but not ſo expeditious) may be practiſed as follows; ſuppoſe only one inclined plane, as deſcribed in the firſt article, and two lever wheels, as before deſcribed, only the beam or axis need not be above twelve feet long and about fifteen inches diameter, and the inclined plane twelve times the length of the elevation, which will reduce the burden, (ſay twenty-four tons,) to two tons or forty hundred weight; and the lever wheels and hand-ſpokes, being above eighteen times the diameter of the axis, reduce the forty hundred to little more than two hundred, except the friction, which will not amount to one tenth more upon a ſingle machine, if properly executed. Suppoſe the elevation to be overcome be twenty-four feet, then the inclined plane would be two hundred and eighty-eight feet, which would take about ſeventy-two revolutions of the great wheel, which I apprehend the weight or power of three men would work up in about half an hour, but ſuppoſe three quarters of an hour. I add no more, but, in witneſs whereof, &c.

III.

III. *Specification of the Patent granted to* Mr. Thomas Cheston, *of Birmingham, in the County of Warwick, Plater; for his Invention of making elaſtic Spring-Buckles, and Spurs, in Gold, Silver, &c. and alſo in other Metals, or mixed Metals, to be plated with Gold and Silver.*

Dated July 1, 1786.

To all to whom theſe preſents ſhall come, &c. Now know ye that, in compliance with the ſaid proviſo, I the ſaid Thomas Cheſton do hereby declare, that my ſaid invention of making elaſtic ſpring-buckles, and ſpurs, in gold, ſilver, iron, ſteel, copper, pinchbeck, or other mixed metals, and alſo in iron, ſteel, copper, and other metals, or mixed metals, to be plated with gold and ſilver, is performed in the following manner; that is to ſay, I take gold, ſilver, iron, ſteel, copper, braſs, pinchbeck, or any metals, or

mixed metals; or I take iron, ſteel, copper, braſs, pinchbeck, or any metals, or mixed metals, plated, or to be plated, with gold or ſilver; which I either forge, ſtrike, cut out, roll, file, or grind, into different forms and ſizes, for buckles, ſpurs, ſhanks of ſpurs, and ſprings for ſpur-necks; which proceſs is performed by placing the metal on an anvil, die, or ſteady, and by ſtriking it repeatedly with a hammer in my hand; or by a hammer or tool placed between two ſupports ſtanding perpendicular, which is commonly called a ſtamp or preſs; then, by fixing a cord, chain, or fly, or any thing which will force the ſaid hammer up, ſo as to give force to ſtrike or ſqueeze down the ſame ſufficiently to give the form of either buckles, ſpurs, the ſhanks of ſpurs, or ſprings for ſpur-necks; which force or preſſure, being repeated, renders the article elaſtic or ſpringy, if the metal is not ſoftened by fire. I alſo take gold, ſilver, iron, ſteel, copper, pinchbeck, or any metal, or mixed metals, or iron, ſteel, copper, braſs, pinchbeck, or any metal or mixed metals, plated, or to be plated, with gold and

ſilver,

ſilver, and place them between two round bodies of iron or ſteel, either plain, or on which is ſunk or engraved the forms of buckles, ſpurs, ſhank-parts of ſpurs, or ſprings for ſpur-necks; and, on paſſing the metals through thoſe two round bodies, (which is commonly called rolling,) the forms of buckles, ſpurs, ſhanks of ſpurs, and ſprings for ſpur-necks, are given, and, by repeatedly paſſing or ſqueezing the metals or mixed metals, plated or to be plated, through the round bodies above mentioned, or by any other mode of preſſure, the ſame become elaſtic, if not previouſly ſoftened by fire, but ſteel in particular. After I have either forged, flattened, cut out, rolled, ground, or filed it into the forms of buckles, ſpurs, ſhanks of ſpurs, or ſprings for ſpur-necks, I turn the bridge or middle part of the buckle towards the under ſide; and I rivet, ſcrew, or dovetail, or braſe, any ſolid or hollow body, or bridge, on the middle or centre of the buckles, for the purpoſe of affixing or putting to (if neceſſary) a chape and tongue. I then ſet or bend the buckle, (either before or after I have ſo affixed the bridge,) and

alſo

alſo the ſpurs, ſhanks of ſpurs, and ſprings for ſpur-necks, in or near the form they are generally worn in, and put them into an oven, ſtove, or any place heated by fire, till they become red hot, or nearly ſo. I then put them into any ſort of liquid, (but oil, water, turpentine, butter, greaſe, with the addition of ſalt, are found to anſwer the purpoſe beſt,) whereby they become or are made hard. I then temper them, either by blazing the oil, turpentine, butter, or greaſe, which will of courſe hang upon them from the proceſs of hardening, or by any gradual or regular heat; (taking care not to render them too ſoft;) by which means of hardening and tempering, the buckles, ſpurs, ſhanks of ſpurs, and ſprings for ſpur-necks, become elaſtic. I alſo take of any of the aforeſaid metals or mixed metals, and either forge, ſtrike, roll, grind, cut out, or file them into the forms of necks of ſpurs, which necks I affix or put to the ſhank or heel part of the ſpur, either by rivetting, ſcrewing, or ſoldering, the ſame. I alſo make elaſtic ſprings by any or either of the means aforeſaid, which ſprings I inlay,

inlay, put to, in, or upon, any parts of the necks or breaſt-parts of ſpurs; and which ſprings receive an elaſtic motion from any preſſure againſt caps or boxes, which I affix to ſpur-necks or breaſt-parts of ſpurs, by means of pins, ſcrews, rivets or dovetails, or by ſoldering; which caps or boxes move upwards, downwards, obliquely, or horizontally, and thereby expoſe the rowel or pricking part of the ſpurs, and, on the preſſure ceaſing, recover their former ſituation by the means of the ſaid elaſtic ſprings; and which caps, or boxes, may be taken off, or put to the necks of ſpurs, at the option of the wearer. In witneſs whereof, &c.

IV. *Specification of the Patent granted to Mr.* JAMES EMERSON, *of the Parish of Bitton, in the County of Gloceſter, Braſs and Spelter maker; for his Invention of making Braſs with Copper and Spelter.*

Dated July 13, 1781.—Term expired.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE that, in compliance with the ſaid proviſo, I the ſaid James Emerſon do hereby declare, that my ſaid invention of making braſs with copper and ſpelter is performed in manner following; that is to ſay, I take ſpelter in ingots, and melt them down in an iron boiler; I then run the melted ſpelter through a ladle with holes in it fixed over a tub of cold water, by which means the ſpelter is granulated or ſholed, and is then fit for making braſs on my plan. I then mix about fifty-four pounds of copper ſhot, about ten pounds of calcined calamine ground fine, and about one buſhel of ground charcoal, together; I then put into a

caſting-

caſting-pot a handful of this mixture, and upon it I put about three pounds of the ſholed ſpelter; I then fill up the pot with the ſaid mixture of copper ſhot, calcined calamine, and ground charcoal. In the ſame manner I fill eight other pots; ſo that fifty-four pounds of copper ſhot, twenty-ſeven pounds of ſholed ſpelter, about ten pounds of calcined calamine, and about one buſhel of ground charcoal, make a charge for one furnace, containing nine pots for making braſs on my plan. My chief reaſon for uſing this ſmall quantity of calamine in the proceſs, is more for confining the ſpelter by its weight, than for the ſake of the increaſe ariſing from it, and I have frequently omitted the calamine in the proceſs. The pots, being ſo filled, are reſpectively put into a furnace, and about twelve hours complete the proceſs; and from this charge I have, on an average, eighty-two pounds of pure fine braſs, fit for making ingots, or caſting plates for making braſs battery wire, or braſs latten, and my braſs ſo made, as aforeſaid, is of ſuperior quality to any braſs made from copper and calamine. In witneſs whereof, &c.

V. *Description of an improved Printing-Press; invented by* Mr. JOSEPH RIDLEY.

WITH A PLATE.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

A Bounty of Forty Guineas was voted to Mr. RIDLEY for this Invention.

THE head of the press is the chief object of this improvement, from which the screw hitherto in general use is taken away, and a perpendicular bar of steel, with a conical end, lodged in a cup on the platen, substituted in its stead. The purchase is obtained by means of a spindle passing through each side of the press, near the bar, to which it is attached by three chains; the two outer ones serving to pull down the bar and platen,

platen, and the middle one to raise or recover them again. To one end of this spindle a lever or handle, about two feet long, is fixed, which, by means of the two chains, pulls down the platen with any force required: at the other end of the spindle is also another lever, with a weight acting as a fly; which weight may be fixed, by means of holes in the lever, at such distance from the centre as may be judged necessary, according to the work to be done.

Description of the Figures.

(See Plate II, in which Fig. 1 and 2 represent a front and side view of the press, with the same letters of reference to both.)

AA. Two strong perpendicular cheeks, joined together by three cross pieces.

B. the upper cross-piece, or head-piece; it sustains the pressure by the two stays CC being firmly screwed to the head-piece, and having at the ends two slit collars to receive the spindle D, which is governed by the lever or handle E, two

feet long, by which the purchaſe is obtained, and which may be aſſiſted, if required, by the other lever F, with a movable weight, on the other ſide of the preſs; this weight only becomes uſeful when power and diſpatch are the leading objects. A weight of lead, W, hangs by a cord over a pulley fixed on the axis at the bottom of the lever F, ſerving to aſſiſt the return of the lever when the platen riſes. The ſpindle D is made broader in the middle than at the ends; the ſpindle and the upright bar G are connected by three chains H H H, two of which afford the pull, and the other reinſtates the bar and platen. Of theſe chains, one is bolted by one end to the lower part of the bar, ſo as to admit the other two, one on each ſide, lengthwiſe of the bar; and the other end of the chain is brought over the middle of the broad part of the ſpindle, and ſcrewed through the bottom, ſo as to afford an opportunity of adjuſting the chain; the two outer chains being, by means of a ſwivel, extended wide enough to admit the centre one between them. A ſtrong bolt muſt paſs through the middle of the ſwivel and the upper part of the bar;

bar; and, being ſtayed faſt on the back of the bar, by a nut or forelock, the other two ends of the chains muſt be brought under the broad part of the ſpindle, one on each ſide the ſingle chain, and ſcrewed to the bottom, as before mentioned. A notch is made in the middle of the ſpindle, in order to receive the three chains, and thereby obtain a great purchaſe. The upper part of the bar G is incloſed, and works in a collar in the middle of the head-peice B; the middle of the bar paſſes by the ſpindle, to which it is coupled by the aforeſaid chains; and the lower end is conveyed through another collar fixed in the middle of the ſhelf I. The cone at the lower extremity is lodged in a ſteel cup K, ſcrewed on the middle of the platen L. The platen is ſuſpended by four ſprings, branching out from the bar, above the ſhelf I, with a hole at each of their ends, in order to receive the tops of the four pillars MM, on which male ſcrews are cut: the baſes of theſe pillars are fixed on the platen, near the four corners. By nuts, properly applied to the ſcrews above the ſprings, the workmen are enabled to adjuſt the platen ſo that it

comes

comes down parallel to the ſtone, and form of letters laid thereon.

NNN the body or frame of the preſs.

V the lower croſs-piece or main-brace, which acts againſt the head, between which are the ribs OO, the coffin S, and the form of letters; and upon that the paper, tympans T, and friſket U, &c.

The ribs, OO, lie acroſs the main-brace V, and extend beyond the two ends of the frame, to which they are ſtrongly ſcrewed. Two long bars of iron, faſtened to the ribs, bear on them the coffin; to the bottom of which ſix pieces of hollow iron are firmly fixed, well fitted and ground ſmooth, in order to procure an eaſy traverſe, by a gentle motion of the rounce P, fixed on the end of the ſpit Q, on which is put a double pulley R, with two ſtraps made faſt thereto, one at each end; the other ends of the ſtraps are attached one to each end of the coffin S, to convey it with accuracy to the deſired place *. In the coffin is placed a po-

* No work with this preſs requires more than one pull.

liſhed

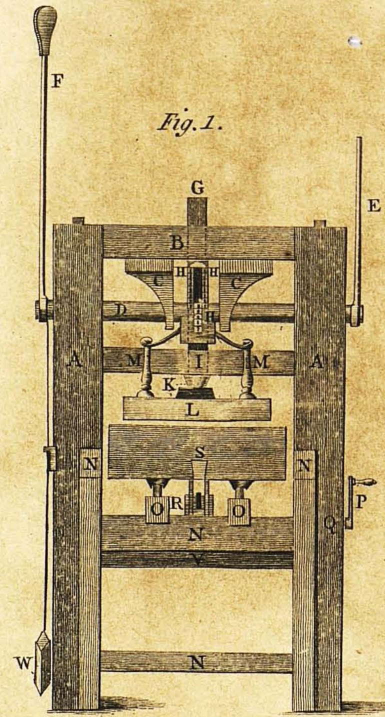


Fig. 1.

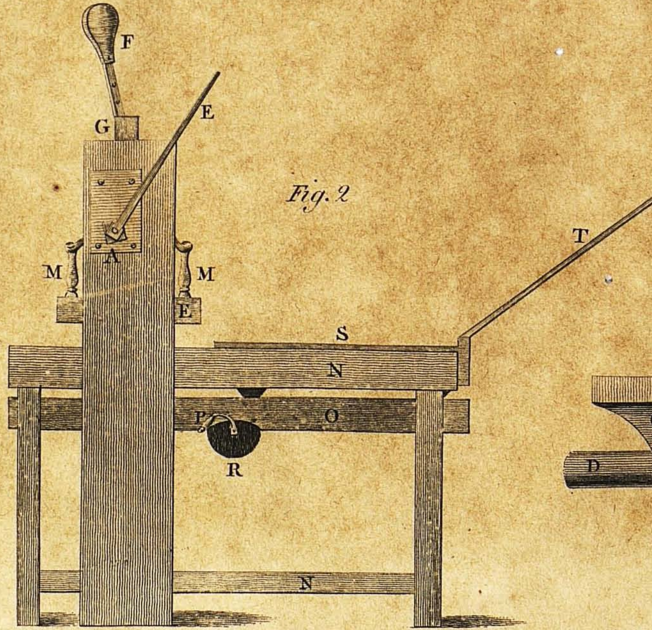


Fig. 2

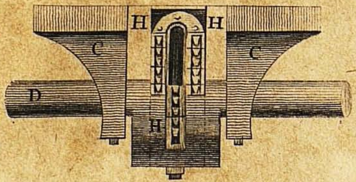


Fig. 3

liſhed ſtone, forming a flat ſurface with the verge of the coffin; it has likewiſe joined to it, by means of two hinges, the tympan T; which, in performing the work of printing, is, as uſual, firſt underlaid with parchment, on that two flannels are laid, over them the upper tympan, with a parchment, as before; then U, a thin frame of iron, the ſize of the tympans, called the friſket, on which is faſtened a piece of paper, cut out in the form of the pages impoſed, in order to keep the ſheet in printing clean, and in its proper place.

In order that the ſtays C C, the ſpindle D, and the chains H H H, with a part of the bar, may be more diſtinctly ſeen, they are ſhewn on a larger ſcale, at Fig. 3.

VI. *Deſcription of a ſelf-moving or ſentinel Regiſter; invented by Mr.* William Henry.

WITH A PLATE.

From the Transactions of the American Philosophical Society.

THE machine conſiſts of the following parts.

A. (Plate III. Fig. 1.) A door or common regiſter, applied in the flue of a furnace. The door is fitted in a frame, and made to ſlide eaſily up and down.

B. A balance or beam, moving on a centre. Its two arms are of unequal lengths, the longer exceeding the ſhorter in the proportion of two to one: the extremity of each arm is formed into a ſegment of a circle, whoſe radius is equal in length to each reſpective arm. Theſe ſegments muſt be equal to the greateſt riſe or fall of each end of the balance when in uſe.

The

The length of the whole beam or balance muſt be regulated by the ſituation of the regiſter A, and the copper veſſel C, hereafter mentioned.

C. A copper veſſel, about thirteen inches diameter, and ten inches deep, with a double bottom and ſides, which are placed about an inch and a half apart from each other, leaving a ſpace between to contain air. The top or cover is brazed on, and the whole made air-tight. Through the top is inſerted a braſs cock, and alſo a braſs or copper cylinder, open at both ends, about two inches and a quarter in diameter, and two feet long; ſo fixed as to riſe fourteen inches above the top, and to reach near to the bottom of the veſſel.

Through the ſide of the innermoſt veſſel, near the top, are ſome holes made, whereby the air in the cavity between the two bottoms and ſides may communicate with the air in the inſide of the veſſel.

D. A phial, two inches diameter, and ſeven inches deep, corked and ſealed, with a hook fixed in the cork, by which the phial is ſuſpended.

These are the principal parts of the machine, which are to be applied as follows.

From the surface let there be a horizontal flue, of a convenient length.

In the walls of the flue, the frame, in which the register slides, is fixed perpendicularly, so that when the register is down, the flue is closed; when the register is drawn up, the flue is opened; and, the higher it is raised, the more is the passage of the fire enlarged.

To the shorter end of the balance, which is supported on a proper fulcrum, at a convenient height, the register is suspended by a chain and a rod; the chain is just long enough to wind over the segment of the circle, at the end of the beam. The register is made so heavy as to descend by its own weight.

At the distance of two, three, or more, feet from the register, and on the flue of the surface, the copper vessel C is fixed, so as to receive heat from the heat passing through the flue. The end of the longest arm of the balance extends directly over the cylinder fixed in the copper; and to it the phial D is suspended, so as to hang within

the

the tube, and by ſuch a length of chain and rod as will allow it to be about two or three inches immerſed in the tube, when the balance is in equilibrio. On the ſame end of the beam on which the phial is ſuſpended, a weight is hung, ſufficient, with the weight of the phial, to over-balance the regiſter, and raiſe it, and conſequently open the flue. When the flue is opened to a due degree, the regiſter is held in that ſituation, until ſo much water is poured into the copper, through the cock, as will fill one third of the veſſel; then ſhut the cock, and pour water into the cylinder, until it riſes high enough to float the phial. By pouring water into the cylinder, the air in the veſſel is compreſſed; and, finding no way to eſcape, as the veſſel is air-tight, it reſiſts the water, and prevents its occupying the whole ſpace; and therefore the upper part of the veſſel is apparently empty. The phial is loaded with ſhot, ſo that it will ſwim about one third above the water. When the water riſes in the tube, the phial riſes with it, in which caſe the regiſter A is ſo balanced that it deſcends, and cloſes the flue.

After this deſcription, the principles on which the ſentinel regiſter acts muſt be obvious to every perſon acquainted with the elaſticity of the air, and that this elaſticity is increaſed by heat. For, when the fire in the furnace is increaſed, the degree of heat in the flue is alſo increaſed: this increaſes the elaſticity of the air contained between the double bottom and ſides of the copper, and conſequently of that which occupies the ſpace above the water, as there is a communication by means of the holes already deſcribed. The elaſticity of the air being increaſed, it expands, and by its expanſion forces the water up the tube; the water, being raiſed, carries the phial with it, whereupon the regiſter preponderating deſcends, cloſes the flue, and, by leſſening the draught of the chimney or flue, deadens or checks the fire in the furnace. By this means again the heat in the flue is diminiſhed, the air in the cavity becomes cooler, and conſequently leſs elaſtic; whereupon the water deſcends in the tube, and with it the phial to its ſtationary point. By the deſcent of the phial the regiſter is raiſed, and opens the flue; by which means it ſtands as a ſentinel

over

over the fire, and preſerves an equal degree of heat.

That this will be the effect of the machine I can atteſt, having uſed it for more than a year.

It is ſubmitted to the curious, whether this machine might not be uſefully applied; firſt, to regulate the heat of chymical and alchymical furnaces, where long digeſtions, and an uniform degree of heat, are required; ſecondly, in the making of ſteel, and in burning of Porcelain-ware, in which a due regulation of the fire is of great importance; thirdly, in green or hot houſes, and in apartments for hatching chickens according to the Egyptian method. With a little alteration it might be applied to the purpoſe of opening doors, windows, and other paſſages, for a draught of air, and thereby preſerve a due temperature of the air in hoſpitals, &c.

VII. *Account of a Machine for pumping Veſſels at Sea, without the Labour of Men.* By Mr. RICHARD WELLS.

WITH A PLATE.

From the TRANSACTIONS of the AMERICAN PHILOSOPHICAL SOCIETY.

WHEN a veſſel at ſea ſprings a leak which cannot be diſcovered, inſtead of exhauſting the crew with continual working at the pumps, they may form, with very little trouble, a machine to diſcharge the water, which will work itſelf, without any aſſiſtance from the hands on-board.

Let a ſpar, or ſpare top-maſt, be cut to the length of eight or ten feet, or more, according to the ſize of the veſſel; mortice four holes through the thickeſt end, through which run four oars, fixing them tight, exactly in the middle; to the four handles of the oars, nail on four blades, (made of ſtaves,)

ſtaves,) the ſize of the other ends, which will form a very good water-wheel, if the oars are ſtrong. Then fix into the oppoſite ends what is commonly called a crank; the iron handle of a grindſtone will ſuit extremely well; if that is not to be had, any ſtrong bar of iron may be bent into that form, wedging it tight, to prevent its twiſting round. Then nail up a new pair of chaps on the fore part of the pump for a new handle to be fixed in, which will point with its outer end to the bow of the veſſel; this handle will be ſhort on the outſide, but as long on the inſide as the diameter of the bore of the pump will admit, in order that the ſpear may be plunged the deeper, and of courſe make the longer ſtroke. The handle muſt be long enough to have a ſlit ſawed up it, ſufficient to admit a ſtave edge-ways, which muſt be faſtened with a ſtrong or iron pin, on which it may work; the lower end of the ſtave muſt be bored, to admit the round end of the crank. Then fix the ſhaft with the oars (or arms) over the gunwale on two crotches; one ſpiked to the gunwale, and the other near the pump; cutting in the ſhaft a circular notch, as well to make it run

6 eaſier,

eaſier, by leſſening the friction, as to keep the whole ſteady. A bolt muſt be fixed in each crotch, cloſe over the ſhaft, to keep it from riſing; as ſoon as the wheel touches the water, it will turn round, and the crank, by means of the ſtave fixed on its end, will work the handle of the pump. If the bore be four inches, and the piſton or ſpear moves eighteen inches at a ſtroke, it will diſcharge 220 cubic inches of water; and, admitting the arms of the wheel to be ſix feet from the centre, it will turn round about 146 times in a mile, or 730 times in an hour, when the ſhip ſails five knots, which is equal to nine hogſheads. If the ſurface of the water in the hold be fifteen feet from the nozzle of the pump, a man can raiſe in an hour, with common working, about thirty-eight hogſheads; this far exceeds the work performed by the wheel, but the calculation is made on pumps of the common ſize; I would therefore propoſe that all veſſels ſhould carry larger pumps, the advantage of which will appear from the following table.

A 4-inch

A 4-inch bore will diſcharge *per* hour, ſailing at the rate of five knots, 9 Hogſheads.

5-inch.	-	-	$14\frac{1}{2}$ ditto.
6-ditto,	-	-	$20\frac{3}{4}$ ditto.
7-ditto,	-	-	$28\frac{1}{4}$ ditto.
8-ditto,	-	-	37 ditto.

Hence we find that a pump of eight inches bore will diſcharge, with the wheel, nearly the ſame quantity that a man commonly raiſes. If both pumps be ſet to work by the crank, double the quantity, or 74 hogſheads will be diſcharged; but if a cog-wheel, of about three feet ten inches, with 51 cogs, be fixed on the end of the ſhaft or axis, and the crank be paſſed through a trundle or lantern wheel, of about two feet diameter, with thirteen rounds, to work with the axis parallel to the deck, and fixed to the pumps, in the manner uſed by brewers and diſtillers, the crank will make about four turns to one revolution of the great wheel, and of courſe deliver 296 hogſheads *per* hour; yet, as the reſiſtance made by the pumps will, in ſome meaſure, impede the motion of the wheel, it will not turn at the rate

 of

of 730 times in an hour: for which ſuppoſe a deduction of one third, which is certainly a great allowance, the quantity then diſcharged *per* hour is about 200 hogſheads, which is more than equal to the conſtant work of five men; thus, if a veſſel, ſailing at the rate of 5 knots, delivers 200 hogſheads *per* hour, equal to five men's work,

6 knots is 240,	-	equal to 6 ditto.
7 knots 280,	- -	equal to 7 ditto.
8 knots 320,	-	equal to 8 ditto.

I am aware of many objections that will be ſuggeſted. In the firſt place it will be ſaid, that pumps of eight inches bore will be too large to be worked by the ſtrength of men, when the wheel cannot be applied. I anſwer, that no more force is required to diſcharge a gallon of water at a ſtroke from an eight-inch bore, than from a four-inch bore; as the ſhort end of the lever or handle to the eight-inch bore, need not be above a quarter part the length of the four-inch, which will give a purchaſe to the ſailor at the long end of the lever, ſufficient to raiſe the piſton or ſpear

a quarter

a quarter the height of what is required in a four-inch bore; for, a piſton moving three inches in an eight-inch bore, and twelve inches in a four-inch bore, will deliver juſt about the ſame quantity of water. It will be farther objected, that in ſtormy weather, when veſſels generally make the moſt water, the wheel could not be put overboard. I own there is ſome force in this objection, but if a remedy is beneficial in ſome caſes, though not adequate in all, it ought not to be totally rejected. Many leaks happen at ſea in moderate weather; and even thoſe which are occaſioned by damage in a ſtorm often continue when the waves are abated. Sailors are frequently unhappily waſhed overboard, and poſſibly thoſe who may have ſurvived the ſtorm are too few, and too weak, to keep the ſhip clear of water, and perform the other neceſſary duties on-board; in ſuch caſes this machine would be evidently uſeful. It may alſo be urged, that the wind at ſuch time may be ſo much a head, that the ſhip cannot make way enough through the water to work the pumps; to which I reply, that when life is in danger, and death ſtares the affrighted crew in

the face, the port of deſtination is not to be conſidered, but the veſſels muſt be ſteered for that ſhore which beſt ſuits the working of the pumps, and keeping her above water.

I would therefore propoſe, that every veſſel ſhould not only have pumps of eight-inches bore, but be provided with a ſhaft, crank, and proper wheels, which might eaſily be ſtowed away in little room, as the paddles of the water-wheel may be unſhipped; and the whole may be procured at a ſmall expence.

References.

(See Plate III. Fig. 2.)

A Top-maſt, or ſhaft of the wheel. B B. Oars or arms of the wheel. C. Crank. D. Pump. E E. Props on the deck, to ſupport the ſhaft.

VIII.

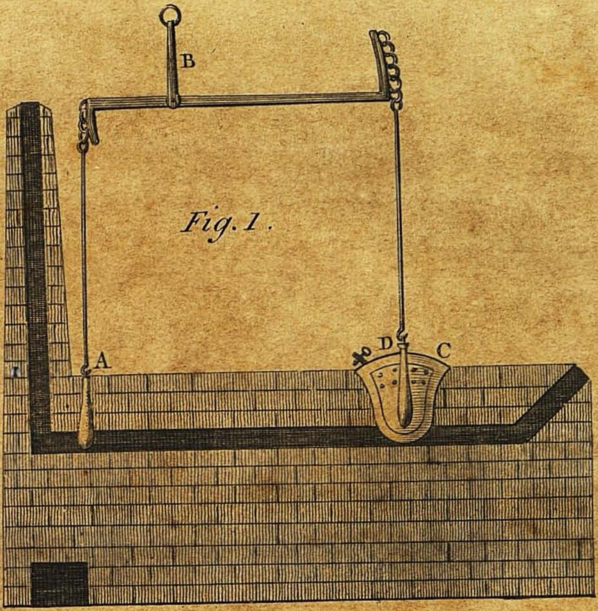
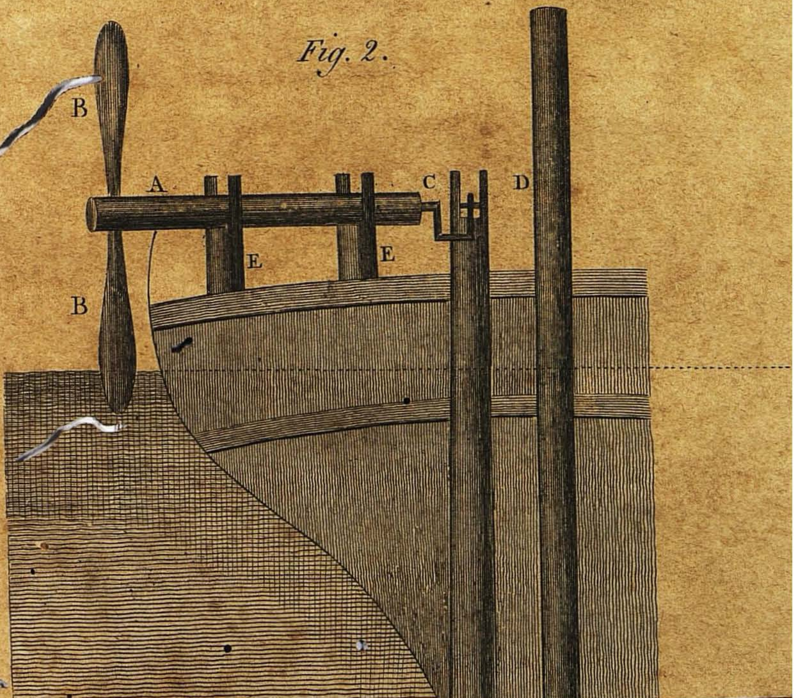


Fig. 1.

Fig. 2.



VIII. *Experiments and Obſervations to inveſtigate the Nature of a Kind of Steel, manufactured at Bombay, and there called* Wootz; *with Remarks on the Properties and Compoſition of the different States of Iron. By* George Pearson, *M. D. F. R. S.*

From the Transactions of the Royal Society of London.

§. 1.

Doctor Scott, of Bombay, in a letter to Sir Joſeph Banks, P. R. S. acquaints him that he has ſent over ſpecimens of a ſubſtance known by the name of *wootz*; which is conſidered to be a kind of ſteel, and is in high eſteem among the Indians. Dr. Scott mentions ſeveral of its properties, and requeſts that an inquiry may be inſtituted to obtain farther knowledge of its nature. This gentleman alſo ſays, that "wootz admits of a harder temper "than any thing known in that part of India; "that it is employed for covering that part of "gun-

" gun-locks which the flint ftrikes; that it is " ufed for cutting iron on a lathe, for cutting " ftones, for chiffels, for making files, for faws, " and for every purpofe where exceffive hardnefs " is neceffary." Dr. Scott obferves, that this fubftance " cannot bear any thing beyond a very " flight red heat, which makes it work very tedi- " oufly in the hands of fmiths;" and that " it has " a ftill greater inconvenience or defect, that " of not being capable of being welded with iron " or fteel; to which, therefore, it is only joined " by fcrews and other contrivances." He like- wife obferves, that " when wootz is heated above " a flight red heat, part of the mafs feems to " run, and the whole is loft, as if it confifted of " metals of different degrees of fufibility." We learn alfo from Dr. Scott's letter, that " the work " ing of wootz is fo difficult, that it is a feparate " art from that of forging iron." It will be pro- per alfo to notice his obfervation, that " the " magnetical power, in an imperfect degree, can " be communicated to this fubftance."

§. 2.

§. 2. *Mechanical and obvious Properties.*

The ſpecimens of wootz were in the ſhape of round cakes, of about five inches in diameter, and one thick; each of which weighed ſomewhat more than two pounds. Each cake had been cut almoſt quite through, ſo as to nearly divide it into two equal parts. It was externally of a dull black colour; the ſurface was ſmooth; the cut part was alſo ſmooth; and, excepting a few *pinny* places, and ſmall holes, the texture appeared to be uniform. It felt about as heavy as an equal bulk of iron or ſteel. It was taſteleſs and inodorous. No indentation could be made by blows with a heavy hammer; nor was it broken by blows which, I think, would have broken a like piece of our ſteel. Fire was elicited on colliſion with flint. Under the file, I found wootz much harder than common bar-ſteel not yet hardened; and than Huntſman's caſt-ſteel not yet hardened. It ſeemed to poſſeſs the hardneſs of ſome kinds of crude iron, but did not effectually reſiſt the file, like highly-tempered ſteel, and many ſorts of crude iron: for, although the

the teeth of the file were rapidly worn down and boken, the wootz was alſo reduced to the ſtate of filings. The filed ſurface was of a bright bluiſh colour, ſhining like hardened ſteel; but ſome parts were brighter than others, and the moſt ſhining places ſeemed to be the hardeſt parts: hence perhaps the reaſon of the ſurface being uneven, and a little *pinny*. Notwithſtanding this uneven and *pinny* appearance of the filed ſurface, a poliſh was produced, which was, I think, at leaſt equal, if not ſuperior, in brilliancy and ſmoothneſs, to that of any ſteel I ever ſaw. The wootz-filings were attracted by the magnet, like common iron-filings.

A cake of this ſubſtance being broken in the part nearly cut through, the fracture exhibited the grain and colour of rather open-grained ſteel, but it was not nearly ſo open as I have conſtantly ſeen the grain of a bar of cement, or bliſter ſteel. The grain of wootz was moſt like that of bliſter ſteel which has been heated and hammered a little, and alſo like ſome kinds of refined crude iron.

The

The ſpecific gravity of wootz, and of ſeveral ſpecimens of ſteel and iron, was found, by Mr. More and myſelf, to be as follows.

N°. 1. Wootz, - - -	7,181
N°. 2. Another ſpecimen of wootz,	7,403
N°. 3. Ditto, forged. - -	7,647
N°. 4. Another ſpecimen, forged, -	7,503
N°. 5. Wootz which had been melted,	7,200
N°. 6. Wootz which had been quenched while white hot, -	7,166
N°. 7. Bar-ſteel from Oeregrund iron,	7,313
N°. 8. Ditto, hammered, - -	7,735
N°. 9. German-ſteel bar, ſaid to be directly from the ore, - -	7,500
N°. 10. Ditto, quenched when white hot,	7,370
N°. 11. Melted ſteel-wire, -	7,500
N°. 12. Ditto, another parcel, -	7,460
N°. 13. Piece of hammered Oeregrund ſteel-bar, after quenching when white hot, - -	7,555
N°. 14. Another parcel of ditto, -	7,570
N° 15. Piece of ſame bar hammered, but not hardened by quenching,	7,693

N°. 16.	Piece of ſteel which had been often heated and cooled gradually, - -	7,308
N°. 17.	Huntſman's ſteel hammered,	7,916
N°. 18.	Ditto, another ſpecimen -	7,826
N°. 19.	Ditto, another ſpecimen, -	7,830
N°. 20.	Ditto, quenched when white hot,	7,771
N°. 21.	Ditto, another ſpecimen ſo quenched, - -	7,765
N°. 22.	Piece of a file quenched while white hot, to produce the appearance called *open grain*,	7,352
N°. 23.	Another ſpecimen of ditto,	7,405
N°. 24.	Piece of ſame file, but not ſo quenched, - -	7,460
N°. 25.	Another ſpecimen of ditto,	7,585
N°. 26.	Piece of very hard ſteel, -	7,260
N°. 27.	Hammered common ſteel, -	7,794
N°. 28.	Another ſpecimen of ditto, and hardened by quenching, -	7,676
N°. 29.	Softeſt and tougheſt hammered iron; from Parkes, an iron merchant, - -	7,716
N°. 30.	Another ſpecimen of dittto, -	7,700

N°.

N°. 31.	Another parcel of ditto, -	7,780
N°. 32.	Another ſpecimen of ditto, -	7,787
N°. 33.	Common hammered iron, -	7,600
N°. 34.	Another ſpecimen of ditto, -	7,450
N°. 35.	Caſt or brittle iron re-melted *,	7,012

§. 3. *Effects of Fire.*

Until the ſubſtance was made red-hot, I could ſcarcely make any impreſſion with a hammer; nor could it be cut through with a chiſel, or wedge, till it was ignited to be of a pale red colour. It had then the peculiar ſmell of iron: it was then malleable, but was much more liable to be cracked and fractured by the hammer than common ſteel; or than, I think, even caſt ſteel. Small and thin pieces are perhaps malleable at lower degrees of fire, but very ſlowly, and not without great care and management. That ingenious ar-

* Bergman ſtates the ſpecific gravities of ſteel and iron as follows: 1, ſteel 7,643.—2, ditto 7,775.—3, ditto 7,727.—4, Ditto 7,784.—5, Ditto indurated 7,693.—6, Wrought iron 7,798.—7, Ditto 7,829.

 tiſt

tiſt Mr. Stodart forged a piece of wootz, at the deſire of Sir Joſeph Banks, for a penknife, at the temperature of ignition in the dark. It received the requiſite temper *. The edge was as fine, and cut as well, as the beſt ſteel knife. Notwithſtanding the difficulty and labour in forging, Mr. Stodart, from this trial, was of opinion that wootz is ſuperior, for many purpoſes, to any ſteel uſed in this country. He thought it would carry a finer, ſtronger, and more durable edge, and point. Hence it might be particularly valuable for lancets, and other chirurgical inſtruments.

Mr. More got a piece of wootz beat into a thin plate; in this ſtate the texture did not ſeem to be uniform, but appeared to be of different degrees of hardneſs, or kinds. A large piece alſo was forged into a thick bar by Sir Thomas Frankland, Bart.

(*a*) The pieces which had been cut in the ignited ſtate above mentioned had ſmooth ſurfaces, with a few ſmall cavities.

* "At the temperature of 450° of Fahrenheit's ſcale."
Mr. Stodart's letter to Sir Joſeph Banks.

(*b*) The

(*b*) The ſubſtance made white hot, by the forge, had the glaſſy ſmooth ſurface of iron, in what is termed the welding, or welling *, ſtate. On ſtriking it gently under the hammer, it was cracked in many places: and by a hard blow it was broken into a number of ſmall pieces, as crude iron and caſt ſteel are at this degree of ignition.

(*c*) The ſurfaces of the fractured pieces (§. 3. *b.*) were black and ragged, or, as it is termed, had no grain. Two or three pieces indeed had yellow and reddiſh ſpots; but theſe were merely tinges from the fire, and diſappeared on applying a few drops of muriatic acid.

(*d*) The pieces (§. 3. *c.*) when cold were readily broken. Some of the fractures exhibited a bright, ſilvery, foliated grain, of ſeemingly an homogeneous ſubſtance, as frequently appears on breaking ſteel which has been quenched, when white hot, in cold water; and as alſo appears on breaking ſteel and crude iron which have been repeatedly ignited, and cooled gradually; but many of the fractures of the ſmall pieces were grey, and cloſe grained.

* This term being from the German word *wellen.*

(*e*) A

(*e*) A piece of the ſubſtance was ignited to whiteneſs, and then quenched in a large bulk of cold water. It was tendered much harder than before, ſo that a good file rubbed off very little. I cannot however, from this experiment, determine whether wootz is ſuſceptible of a greater, or ſo great, a degree of hardneſs as ſome kinds of ſteel uſed by the Engliſh artiſts.

(*f*) The piece (§. 3. *e*.) was ignited in a cloſe veſſel, and let cool in the aſhes of the fuel. It became much leſs hard, but I never could, by annealing, bring down the temper to the degree of any of our ſteels; on which account it is far more difficult to forge. The interior parts of a thick piece of wootz could ſcarcely be ſoftened at all by annealing.

(*g*) A piece of this ſubſtance, about 500 grains in weight, (wrapped in paper, to afford carbon enough to prevent oxidation, without ſuperſaturating the metal with carbon,) was expoſed in a cloſe veſſel, for above an hour, to a pretty conſiderable fire. On cooling, the ſubſtance was found to have retained its form, but it was of a ſlate-blue colour, and many round particles, as

large

large as pins heads, adhered to its ſurface, as if matter had oozed out by melting. The degree of fire, indicated by Wedgwood's pyrometer, was 140°.

A piece of our ſteel, which had been part of a file, was expoſed in a ſimilar manner, but to rather more fire. It retained its form, and its ſurface remained ſmooth.

A piece of crude or caſt iron, by expoſure to this degree of fire, under the circumſtances juſt mentioned, was fuſed: in a temperature of about 120° its ſurface became covered with a number of ſmooth roundiſh maſſes, as if fuſion had begun.

(*h*) 500 grains of wootz were expoſed, as in the former experiment, but to a fiercer fire, in my forge. The temperature was 148°; which is 23° more than Mr. Wedgwood ſtates he could produce in a common ſmith's forge. My forge is movable. The fuel is contained in a pan of caſt iron lined with fire-bricks, as propoſed by Mr. More. The bellows are only of the 22-inch ſize. In this fire the ſubſtance was melted, with the loſs of a few grains in weight. The ſurface was quite ſmooth. It broke under the hammer like caſt

ſteel.

ſteel. It received as fine a poliſh as that which had not been melted. Under a lens, the poliſhed ſurface appeared quite uniform and cloſe, with a few pores at equal diſtances. The poliſhed unmelted wootz had ſtill fewer pores, and at unequal diſtances, but with ſeveral fiſſures. Its grain, in the opinion of Mr. Stodart, was like that of caſt ſteel of the beſt quality; conſequently it was uniform, and rather cloſe. Its ſpecific gravity, as already ſtated, was about 7,200.

500 grains of ſteel wire were melted under the circumſtances juſt mentioned. The maſs fractured in the ſame manner, and had the ſame kind of grain, as the wootz which had been melted.

I did not always ſucceed in melting wootz, or ſteel, although the fire denoted by the pyrometer was of the ſame, or a higher, temperature than that in which at other times they were melted. Nor is this reſult difficult to be accounted for by thoſe who conſider the different temperatures in different parts of the ſame fire; even ſuppoſing the inſtrument to invariably indicate the real temperature.

(*i*) Equal

(*i*) Equal weights, namely, 500 grains, of wootz, of ſteel wire, and of grey pig-iron, were expoſed for half an hour, in the ſame crucible, well covered, to a pretty conſiderable fire. On cooling, the pig-iron was found to have been fuſed, but the other two ſtates of iron had retained their form. The pyrometer was contracted to near the 140th degree.

(*k*) I melted together 500 grains of ſteel wire and 50 grains of grey pig-iron, in a cloſe veſſel, without any addition of carbon. The ſteel ſo alloyed was more brittle than caſt ſteel. Its grain was coarſer, and it had not the uniformity of texture and colour of melted wootz; (§. 3. *h.*) but had more reſemblance to ſome of the fractures of the unmelted wootz. (§. 3. *d.*).

§. 4. *Effects of Fire and Oxygen Gaz conjointly.*

A piece of wootz ignited to whiteneſs, being expoſed to a blaſt of air in the charcoal-fire of the forge, emitted ſparks, like thoſe of iron and ſteel in theſe circumſtances: at the ſame time it melted in the ſtate of oxide of iron.

 §. 5.

§. 5. *Experiments with diluted Nitrous Acid.*

(*a*) 200 grains of the ſubſtance under examination were firſt digeſted, and afterwards boiled, in three ounce-meaſures of concentrated nitrous acid, mixed with an equal bulk of water. A diſſolution took place, with a diſcharge of nitrous gaz. The mixture, reduced by boiling to half its bulk, was diluted with water, and, while boiling-hot, was filtrated through paper. Excepting a few grains of black matter, the whole mixture paſſed through the filtre. The filtrated liquor, evaporated to dryneſs, afforded a matter, which, after being kept red-hot for two hours, was a light, ſpongy, reddiſh ſubſtance, that weighed 270 grains.

(*b*) 30 grains of the reddiſh ſubſtance, (§. 5. *a.*) digeſted in half an ounce of concentrated acetic acid, on filtration and evaporation to dryneſs, yielded one grain and a half of grey matter, which was aſcertained to be oxide of iron.

(*c*) The blackiſh matter left upon the filtre (§. 5. *a.*) was repeatedly digeſted in diluted nitrous acid. The firſt filtrated liquors afforded, on evaporation,

poration, a few grains of oxide of iron, and the laſt a very minute quantity of the ſame.

(*d*) 60 grains of the reddiſh matter, (§. 5. *a.*) with a bit of ſugar, were digeſted in diluted nitrous acid. The filtrated liquor, on evaporation to dryneſs, yielded a few grains of a browniſh ſubſtance, which, after many experiments, was found to be oxide of iron. Of theſe it will be ſatisfactory if I mention, that a little of the browniſh ſubſtance, fuſed with the fluxes, by the flame and blowpipe, did not afford a reddiſh or purple glaſs from the exterior or white flame; nor a colourleſs one from the interior blue flame.

Theſe experiments (§. 5. *a—d.*) were alſo made on ſteel wire, with the ſame reſults.

(*e*) A few drops of diluted nitrous acid were applied to pieces of poliſhed wootz, ſteel, and iron. The parts of the wootz and ſteel ſo wetted became black, but the iron was made brown.

§. 6. *Experiments with diluted Sulphuric Acid.*

This acid liquor was made by mixing one meaſure of concentrated ſulphuric acid with three of pure water.

Before I felt any degree of confidence in theſe experiments, with reſpect to the carbon, and the proportions of hydrogen gaz from wootz and water, I repeated them often; but I here think it neceſſary to relate only one experiment.

200 grains of wootz, from the ſurface of which oxide, and all other extraneous matter, had been carefully rubbed off, were put into a retort, with five ounce-meaſures of diluted ſulphuric acid. In the temperature of 55° of the room, in twenty-four hours, about a pint-meaſure of gaz came over, into a jar filled with, and ſtanding over, lime water; without any diſturbance of its tranſparency, or diminution of the bulk of the gaz. The liquid in the retort became green, and a quantity of black wool-like ſediment appeared upon the undiſſolved wootz.

On

On applying the lamp, the diſſolution went on rapidly, and black matter continued to be ſeparated, and gaz to riſe, till the whole of what ſeemed to be ſoluble in the menſtruum diſappeared. When about three-fourths of the matter were diſſolved, a white ſediment, like the *ſiderite* of Bergman, began to appear, and increaſed as the diſſolution went on.

By ſtanding, ſtill more of this white ſediment fell down; and green cryſtals, apparently thoſe of ſulfate of iron, formed a ſtratum which lay over the white matter. The black matter adhered to the ſides of the retort, it appeared alſo upon the ſurface of the liquid, and ſome of it was depoſited under the white ſediment.

This experiment was alſo made with ſteel wire, and with the tougheſt iron wire.

TO BE CONCLUDED IN OUR NEXT.

IX.

IX. *Obſervations on the Uſe of Sithes for reaping Corn, &c. publiſhed by the* Patriotic Society *of* Milan.

WITH A PLATE.

From the Transactions of the ſaid Society.

It has been a queſtion in agriculture, whether ſithes or ſickles were moſt advantageouſly uſed for reaping corn. All perſons agree that much more work, and with leſs labour, may be done with the ſithe than with the ſickle; but ſome ſay, that the ſaving of time and labour is not ſufficient to compenſate the diſadvantages attending that method.

It is ſaid that the ſithe ſhakes the ear, ſo that many of the grains are loſt; that it lets the corn fall, after cutting it, in a confuſed and ſcattered ſtate, ſo that either much of it is loſt, or a great deal of time is conſumed in gathering it together; that it can only be made uſe of in land which is very

very even and free from ſtones; that it does not leave ſufficient length of ſtubble in the ground to lay the corn on when cut; that it mixes bad weeds with the corn, the ſeeds of which are ſown the next year; and, laſtly, that the uſe of the ſithe is prejudicial to the health of the reaper.

Theſe objections, however, are either of no weight, or they are made by thoſe who are not acquainted with the good ſithes which have been adapted to this purpoſe, and with the proper manner of uſing them. With a good ſithe, properly managed, the corn, after being cut, remains at firſt upright, and then falls very gently upon the rake fixed to the ſithe, without any ſhake or jolt; or at leaſt with leſs than that which it receives when reaped with a ſickle. With reſpect to the loſs of grain, that proceeds chiefly from the corn being too dry; conſequently it ſhould be reaped only upon proper days, and proper times of the day, which is much more eaſily done with the ſithe than with the ſickle, becauſe the work is ſo much ſhorter. The ſtalks, kept together by the rake, may be laid upon the ground, or rather againſt the corn not yet cut, in ſo regular and

collected

collected a ſtate, that thoſe who gather and tie the ſheaves, whether they are women or children, have nothing but their own negligence to accuſe if any thing is left behind. When land is properly ploughed and harrowed, it is ſufficiently even; and, in ſuch as is ſtony, the only precaution neceſſary is to keep the ſithe a little higher in uſing it, that it may not ſtrike againſt the ſtones. If the ſtubble left in the ground be ſhort, the ſtraw which is cut off will be the longer; and the latter is certainly of more value than the former, which only ſerves to incommode the cattle which afterwards go to feed in the field. The graſs will grow more thick, by being cut off near the root; and it is better that the ſeeds of it ſhould be collected from the barn-floor, than that they ſhould fall in the field. The manner of procuring ſeed well cleared from all pernicious weeds, to ſow in the following Autumn, is well known. If the poſture, and manner of uſing the ſickle, be compared with the management of the ſithe, it muſt very clearly appear that the latter is attended with leſs inconvenience, and leſs danger. It is indeed true that the workmen who uſe the ſithe are ſome-

times

times afflicted with diſorders of the kidneys, as Duhamel obſerves, but that inconvenience ariſes from their not keeping themſelves in a proper poſture, of which more will be ſaid hereafter.

The ſaving in time and expence is very great indeed. According to Freville, (*Nouveaux Elémens d'Agriculture*, chap. I.) a field, the reaping of which with a ſickle coſts, in the neighbourhood London, thirty-two ſhillings, would coſt, in the county of York, where reaping is performed with a ſithe, only twelve ſhillings and ſix-pence: and, according to Deliſle, (Duhamel, *Elémens d'Agriculture*, §. 4. chap. I.) the ſame quantity which, with a ſickle, requires one day with two hundred men, (or in that proportion,) with a ſithe would require only ſeventy men, and the ſame number of women, or children *. But, ſetting calculation aſide, a certain argument of the advantage of ſithes, in reaping corn, may be drawn from ob-

* The expence of the inſtrument cannot be an objection to its uſe, it being very trifling; indeed, except the iron, which cannot coſt much, the labourer may make it itſelf:

ferving that their ufe is daily increafing in thofe countries where they have not yet been generally adopted; and they are never given up when once they have been brought into ufe.

Upon thefe principles the patriotic fociety was induced to give fome attention to the ufe of fithes for reaping; and two ingenious fmiths, (Jofeph Bolgie of Milan, and Peter Francis Ponti of Defio,) prefented to the Society two fithes invented by them for that purpofe. The fociety thought that in Lombardy, where the number of perfons to be procured for the work in queftion is by no means great, and where there is often danger of injury from hail upon the very day of reaping, great advantages muft attend the ufe of an inftrument which, by diminifhing labour and fhortening time, would, at lefs expence, more quickly fecure from danger that harveft for which the farmer had toiled through the whole year.

The fociety therefore deputed two of their members, Don Francifco Molina, and Don Andrea de Carli, to examine into the merit of the fithes prefented

presented to them; after proper trials, they were found by no means to answer the proposed end. This failure determined the society to send to those parts in which sithes are made use of for reaping; and, having procured a model of a sithe from Silesia, they caused one to be made of a proper size. It was first tried upon corn, and afterwards upon millet; and, although the first sithe was not accurately made, and the reaper had never before made use of such an instrument, yet it was found that nearly half the usual time was saved, and that the labour and fatigue were much diminished; the corn also was cut without receiving any shock that could be hurtful to it, and fell in an even and regular state, so that it was afterwards easily bound up in compact sheaves.

From these circumstances the society resolved to publish a figure of such an instrument, with a description, and an account of the manner of using it, conceiving it must be convenient and advantageous to farmers. And as another sithe, somewhat different from the first, and generally used

in Auſtria, was afterwards preſented by Signor de Brambilla, ſurgeon in the army of his Imperial Majeſty, they will, after deſcribing the Sileſian ſithe, mention in what the Auſtrian one differed from it; in order that whichever ſhould be found moſt convenient may be adopted.

The ſithe for reaping is ſo ſimple an inſtrument that the figure of it almoſt renders a deſcription unneceſſary. In Fig. 1. (Plate IV.) is ſhewn the Sileſian ſithe tried by the Society; the difference between that and the Auſtrian one we ſhall mention in our deſcription. The firſt, or Sileſian ſithe, differs very little from the ſithe we commonly uſe for mowing graſs, except that the blade is rather ſmaller, like that uſed in ſome mountainous parts of our country; to it are added four teeth of wood, parallel to the blade, fixed and ſecured in a proper manner, and intended to keep the corn together after being cut, ſo that, inſtead of its falling in a confuſed ſtate, the reaper may lay it down in a regular and compact one.

The ſecond, or Auſtrian ſithe, is ſimilar to the former, except that the blade is larger; conſequently

quently the wooden teeth, of which there are five, are longer; the handle alſo is more flat, and rather crooked.

In the firſt, the handle *a b* (ſee Plate IV. Fig. I.) is two Milaneſe *braſſes** and nine inches and a half in length; the blade *b c* is one *braſs* three inches and a half; the piece of wood in which the teeth are fixed, one *braſs* one inch and a half.

In the ſecond, the handle is two *braſſes* and ſeven inches long; the blade, one *braſs* eleven inches; the piece in which the teeth are fixed, eleven inches and a quarter. The proportions of the other parts may be conceived from the figure.

The difference in the conſtruction of theſe two ſithes makes it requiſite to uſe them in a different manner, but that will be better acquired in practice than by precept. Such of our countrymen as are accuſtomed to the uſe of the common ſithe will very ſoon find out the moſt convenient and advantageous manner of uſing theſe new kinds of

* One hundred Milaneſe *braſſes* are equal to fifty-eight Engliſh yards and a half.

of ſithe, and of laying down the corn properly when cut.

It ſhould however be obſerved, that in mowing graſs the feet are kept almoſt parallel to each other, whereas in reaping corn they ſhould be kept upon a line, one behind the other, thruſting the right foot forward, and drawing the left towards it. This is neceſſary, becauſe when graſs is mowed it is left to fall juſt where it is cut; but when corn is cut it is to be carried and laid in a proper manner againſt that which is not yet cut, and which is at the left hand of the reaper; and, if the feet were kept parallel to each other, the reaper would be obliged to extend and turn his body in a very inconvenient manner.

POSTSCRIPT.

After having made public theſe obſervations, the ſociety made farther experiments upon the ſubject, in which it was found that when, on account of very wet weather, the ſtalks of the corn are bent down, the wooden teeth of the forementioned ſithes are apt to lay hold of ſome

ears,

ears, to the ſtalks of which the iron does not reach, and conſequently, not being cut below, they are pulled ſo that the grain is ſcattered. This happens chiefly when the reapers, not being yet ſufficiently accuſtomed to that kind of ſithe, do not know how to adapt it to particular circumſtances; as was the caſe with ſeveral perſons who, in this preſent year, wiſhed to make uſe of it. To remedy this inconvenience, the above mentioned Peter Francis Ponti thought of adding to the common ſithe a *gatherer* or *collector* made of cloth, as may be ſeen at Fig. 2.

a b c is a common ſithe; *c d m l o f n e* is the *gatherer*; which at *c d e* is compoſed of a thin plate of iron, having at its extremity a hollow for receiving the point of the blade. At *e d* are holes for ſewing in the cloth, which is coarſe, light, and of low price; it is alſo fixed to two thick iron wires, of which the upper one is continued to *f*, where it terminates in a hole in the handle; the other is fixed to the back of the blade. The manner of fixing this *gatherer* to the blade of the ſithe will be better underſtood by referring to Fig. 3, which repreſents

represents one of the irons which, by means of a screw, are fastened to the back of the sithe. These irons proceed from, and make part of, the upright irons *m n l o*, which serve to keep the *gatherer* extended.

Although the above mentioned contrivance is very simple, and costs very little, yet Francis Pratesi, beadle of the society, has attempted to render it still more simple, by substituting, in place of the *gatherer*, two iron hoops, shewn in Fig. 2 by dotted lines, marked *h g*, *k i*, with a cross-piece *p* which connects them; saving, in this manner, the cloth, and the plate of iron, used in Ponti's contrivance.

Experiments made with both these instruments have shewn, that the sithe with Ponti's gatherer is preferable in general, as it does not leave an ear of corn behind; and that the alteration proposed by Pratesi is chiefly advantageous when there is no short corn, or other plant, to get between the iron hoops.

Fig. 3
a
c
d
m
l
f
g
o
b
Fig. 2
a
c
b
Fig. 1

REPERTORY

OF

ARTS AND MANUFACTURES.

NUMBER XXVI.

X. *Specification of the Patent granted to Mr.* Felton Mathew, *of Three-Cranes Wharf, in the City of London, Merchant; for his Method of completely separating the Beer from Yeast, and preserving the Yeast for a great Length of Time, and in any Climate.*

Dated Feb. 22, 1796.

To all to whom these presents shall come, &c. Now know ye that, in compliance with the said proviso, I the said Felton Mathew do hereby declare,

declare, that my ſaid diſcovery of a method of completely ſeparating the beer from yeaſt, and preſerving the yeaſt for a great length of time, and in any climate, is deſcribed in manner following; that is to ſay, to ſeparate the beer from yeaſt, I uſe a preſs with a lever, the bottom made of ſtout yellow deal, oak, or any other timber fit for the purpoſe, raiſed with ſtrong feet a convenient height from the ground, ſo as to admit the beer to run off into whatever is prepared to receive it. Into the back of it is let a ſtrong piece of timber, or any other fit material, to ſecure one end of the lever, the top of which is ſecured by being well wedged up to a girder, or the joiſts, at the top of the building; in this piece of timber is mortiſed one end of the lever, which is faſtened into this mortiſe with an iron pin, or otherwiſe properly ſecured; the whole well ſecured with iron work. The yeaſt is then put into bags, made of ſail-cloth, or any other ſtrong cloth or material, and carefully tied or ſecured, then placed flat on the preſs; a board is then laid on it, and the lever let down upon it, and weights are then

hung

hung upon the other end of the lever, by means of hooks, or any other way that may be more convenient for the ſituation of the place; which weights are added as the beer runs from it, ſo as not to burſt the bags, or force the beer out too thick; to prevent this, I find a trough, made the ſize of the bag, with a falſe bottom bored full of holes, (the ſides and ends likewiſe of the trough bored full of holes, this placed on the preſs, and the bag put into it, with a top to come upon the bag, with blocks on it, ſo as to admit the lever to act upon it,) anſwers very well: this may be uſed with a looſe cloth inſtead of a bag, but I think not with ſo much advantage. When a ſufficient weight has been added to the lever, ſo as to completely preſs the beer out, (which may be done by a ſcrew-preſs, if there is not an opportunity of giving ſufficient force to the lever,) the yeaſt that remains in the bags will crumble to pieces, like flour; it muſt then be thinly ſpread upon frames, made with thin canvaſs, hair-cloth, or any other thing that will freely admit the heat to paſs through it, in a room, kiln, or ſtove, or other place where a

regular heat can be kept up to the temperature of from about eighty to ninety degrees; obſerving to break it finer as it dries, by paſſing a board, or other fit thing, lightly over it. When completely dry, put it in tight caſks, or bottles, ſo as to exclude the air, or any damp, from it, and it will then keep good for a great length of time, and in any climate. When wanted for uſe, it may be diſſolved in a ſmall quantity of warm wort, or ſugar and water, of the temperature of from about eighty to ninety degrees, when it poſſeſſes the ſame quality as freſh liquid yeaſt. In witneſs whereof, &c.

XI. *Specification of the Patent granted to Mr.* JOSEPH SPARROW, *of the Town of Nottingham, Framework-Knitter; for his Method of raiſing, removing, and delivering Earth or Water, by which Rivers, Canals, or Fiſh-Ponds, may be made, or emptied, and alſo of raiſing and removing heavy Weights of Coal, Limeſtone, or other Stones, from and out of any Boat, Barge, or Veſſel, in a navigable River or Canal, and delivering the ſame upon the Wharf or Shore, or into any Waggon, Cart, or other Carriage, with more Facility, and leſs Labour and Expence, than by any Method hitherto known.*

WITH A PLATE.

Dated October 16, 1793.

TO all to whom theſe preſents ſhall come, &c. Now KNOW YE, that the ſaid Joſeph Sparrow, in compliance with the ſaid proviſo, and performance of the condition therein contained, doth hereby deſcribe and aſcertain the nature of his

 ſaid

ſaid invention, in and by the plan thereof to theſe preſents annexed, and doth hereby declare, that the ſame conſiſts and is compoſed of the ſeveral particulars, and is to be performed in manner, as herein after is particularly mentioned; that is to ſay, Fig. 1, AAAA, (Plate V,) the carriage-part of the machine, made of wood; which pieces of wood are faſtened together at each end with two ſtrong ſcrews; the ſaid carriage-part runs on the four wheels BBBB, and ſupports the uprights and the machinery affixed thereon. CC, two upright poſts, made of wood, fixed (by tenons and mortiſes) in the carriage-part AA. DDDDDD, ſupporters of the upright poſts, fixed at the bottom (by tenons and mortiſes) in the carriage-part AA, and faſtened at the top to the upright poſts CC, by tenons and mortiſes. E, a croſs beam of wood, fixed at each end thereof into the ſides of the upright poſts CC, by tenons and mortiſes. F, a beam, lying over and faſtened to the top of the upright poſts CC, by tenons and mortiſes. G, a circular ring of wood, faſtened to the upright poſts CC; namely, one ſide thereof ſix inches from the top of one of the

the upright pofts, and the other fide in a declined pofition to the other upright poft (above the beam E, called the crofs beam) at the letter *a*; the upright pofts dividing the circular ring in two equal halves. H, a piece of wood, affixed at one end into the middle of the beam F, and at the other end into the middle of the circular ring G: there is another piece of wood, in the fame pofition, on the contrary fide of the beam F and the circular ring G, to anfwer each other; thefe two pieces of wood are ftays to the circular ring G. I, an axis, defcribed in Fig. 4. J J, a beam of wood, called the principal beam or lever, paffing through the axis I, and turning and balancing upon the pin *b* in the axis I, (fo as to move under the circular ring G, with the roller P between,) at the centre of the faid principal beam or lever; fuch pin working in two collars or ferrels of iron; one of fuch collars or ferrels being faftened or fixed on each outfide of the axis I. K, a flot or piece of wood, defcribed in Fig. 5, fixed at the end of the principal beam or lever, by means of the iron pin C fhooting through both. This flot is fixed, at the end of the principal beam or lever JJ, higher or lower, by means

of

of the different holes *d d d d*, so as occasion (on account of the depth of the river, canal, fish-pond, &c.) may require. L, a frame of wood, in which turns the barrel M; which frame is screwed to the top of the principal beam or lever JJ. M, a barrel, whereon is wound, by a handle, a rope for raising the catch or piece of iron in Fig. 2, marked *g*. N, an upright piece of wood, whereon to fasten the rope *i*, worked by the windlass, Fig. 3. O, a piece of wood called the stay or strengthener, affixed underneath the centre of the principal beam or lever J J with four strong screws *f f f f*, sunk into the wood, going through the stay and principal beam or lever, and fastened at the top with nuts; which stay passes through the axis I, along with the principal beam or lever. P, a small roller of wood, fastened on the uppermost side of the principal beam or lever J J, at that part exactly under the circular ring; so that, when the principal beam or lever JJ is performing its operation, the roller will work on the circular ring, which will prevent friction between the principal beam or lever and circular ring. The dimensions of Fig. 1 may be as follow; the carriage-part, AAAA, nine feet square

within.

within. The wheels, two feet each in diameter. The upright poſts C C, from the ground to the beam F, fifteen feet. The ſpace between the upright poſts, nine feet. The circular ring G, made of oak-wood, ſix inches ſquare, and to be of a diameter ſufficient to paſs through the given points in the upright poſts. The principal beam or lever J J to be forty-five feet long; or the dimenſions may be varied in proportion, according to the uſe to be made of the machine.

Fig. 2. A A. Two upright poſts of wood, to which the trunk B is faſtened by four ſtrong ſcrews *a a a a* in each upright. B, the trunk, for raiſing, removing, and delivering, earth, coals, limeſtone, and other ſtones; to be made of wood, and ſix feet long, four feet broad, and three feet deep, or larger, at diſcretion. C C, two doors at the bottom of the trunk when open; each door to turn on a ſtrong hinge; the two doors open in different directions, when diſcharging or unloading the earth, coals, limeſtone, or other ſtones. D marks the barrel, made of ſolid wood, on which the rope or chain laps round. The ſame rope or chain parts in two directions *b b*, one of

which is faſtened to one of the doors at the bottom of the trunk, and the other is faſtened to the other door. E is a pulley of iron, faſtened at the top of the upright pieces of wood A A. F, a croſs beam, faſtened to the top of the two upright poſts A A, and hung, by a chain and hook, to the end of the ſlot or piece of wood marked K in Fig. 1. Through the pulley E paſſes a rope, which is faſtened at one end to the catch of iron g, at a place marked *e*, and the other end is faſtened to the barrel M in Fig. 1; taking its direction between the two upright pieces of wood C C in Fig. 1, and paſſing under the circular ring G in Fig. 1, and through a pulley that is faſtened to one ſide of the axis I in Fig. 1.

Fig. 3, a windlaſs, the form and principle of which are publickly known; the upright poſts on which the ſame is worked being fixed on the carriage A A A A, four feet ſquare, or larger if the work requires it, with ſupporters, ſhewn in the drawing, and running on four wheels B B B B. This is to work the machine Fig. 1, as after mentioned, and, while performing its office, is to be ſecured in its ſtation by a rope; each end of which

which rope, being faſtened to the windlaſs by hooks at each corner E E, is to be tied round a pin of iron, or wooden ſtake, driven into the ground at L.

Fig. 4 ſhews the axis I in Fig. 1, with the centre point of ſteel at the bottom, and ſpindle of iron at the top. A, the vacant ſpace between the ſides of the axis, through which the principal beam or lever J J, in Fig. 1, paſſes, and the ſame are to be made to fit each other. The centre point turns in a gudgeon of braſs, let into the centre of the croſs beam E; a plate of iron nailed to the croſs piece covering the gudgeon, and in which plate of iron is a hole, through which the centre-point ſhoots into the gudgeon. The ſpindle of iron at the top ſhoots through the centre of the beam F, in an iron ferrel fixed on the uppermoſt ſide of the beam F.

Fig. 5, the movable ſlot or piece of wood K in Fig. 1. A, the vacant ſpace into which the end of the principal beam or lever J J, in Fig. 1, is placed and faſtened.

Fig. 6 deſcribes a trunk to be uſed for raiſing, removing, and delivering water; the upright

poſts, and the beam at the top of them, as in Fig. 2; and to be fixed to the ſlot K in Fig. 1, ſame as Fig. 2. Between the two upright poſts is a roller R, turning upon iron axles, in ferrels fixed in the ſides of the ſame two upright poſts. The ſides and ends of the trunk to be the ſame as in Fig. 2. In the bottom of the trunk P is an oblong hole S, three feet long and two feet wide; over ſuch hole opens and ſhuts the door A, which turns on a hinge at the end of it; ſuch hinge being fixed, by ſcrews or nails, to a piece of wood (the ſame thickneſs as the door) fixed to the bottom of the trunk by ſcrews. The door to be made larger, by two inches at the ends and ſides, than the hole at the bottom of the trunk; and the bottom of ſuch door to be covered or caſed with leather, to fit water-tight, or as near thereto as may be. On the top of the door is to be affixed a piece of lead Q, of the weight of twelve pounds, or upwards. On the uppermoſt ſide, and at the top, of the ſame door, is faſtened one end of a rope, the other end of which paſſes over the roller R, and then, ſame as in Fig. 1, to the barrel M in Fig. 1; ſeveral yards of rope hanging

over,

over, and beyond, the laſt mentioned barrel M, to be pulled or uſed by the hand.

Fig. 7. T, a lever made of wood, turning on an iron pin U, fixed in the two iron uprights V V. The bottom bar being alſo of iron, turning on a ſwivel of iron W, fixed on a portable ſtand with three legs, made of wood.

The manner in which the machinery is worked. The machinery Fig. 1, together with Fig. 2, hung to the ſlot or piece of wood K, in Fig. 1, by a chain and hook, (for the purpoſe of raiſing, removing, and delivering earth, coals, limeſtone, and other ſtones,) being placed on the bank or ſide of the river, canal, or fiſhpond, the windlaſs, Fig. 3, is to be fixed on the oppoſite ſide of the river, canal, or fiſhpond, or at a convenient diſtance oppoſite the ſide of Fig. 1, and the rope on the barrel of the windlaſs is to be affixed to the top of the upright piece of wood N in Fig. 1. By winding up the rope on the barrel of the windlaſs, the end of the principal beam or lever J J, with Fig. 2 hanging thereto, is raiſed; and, by looſing or unwinding the ſame rope, the ſaid end of the principal beam or lever, with Fig. 2 hanging

thereto,

thereto, is let down to the boat, barge, or veſſel, river, canal, or fiſhpond, being declined down by means of the circular ring G. Before the end of the principal beam or lever is ſo let down, the rope wound on the barrel M in Fig. 1 is to be looſened, ſo that the catch *g* in Fig. 2 will fall into the teeth of the barrel D in Fig. 2, which, made in the common way, will wind up without being ſtopped by the catch, but the catch will prevent the barrel unwinding the rope which is round it. The rope on the barrel D muſt be wound up, ſo as to ſhut the doors in the bottom of the trunk B in Fig. 2; then the trunk is to be filled with what is intended to be raiſed and removed; then the windlaſs, being worked, will bring down the end of the principal beam or lever, to which the rope is affixed, and raiſe and bring the other end, with the trunk thereto, over the wharf, or ſhore, or any waggon, cart, or carriage there; and the catch *g* in Fig. 2 being raiſed by winding up the rope on the barrel M in Fig. 1, (which will then be upon or near the ground,) the rope or chain on the barrel D, in Fig. 2, will be ſet at liberty, and the weight of the contents of the

the trunk will preſs open the doors at the bottom of the trunk, and diſcharge ſuch contents upon the wharf or ſhore, or into any waggon, cart, or other carriage there, being underneath the ſaid trunk. This being done, the rope on the barrel M muſt be looſened as before; and, the rope on the barrel of the windlaſs being looſened, the trunk will be returned to the place where it is to be filled. For expedition there may be two parts of Fig. 2, one to be filling whilſt the other is raiſing, removing, and delivering; and, in ſuch caſe, the Fig. 2 may be taken off the hook on the ſlot or piece of wood K in Fig. 1, by the uſe of the movable lever Fig. 7. In uſing the machine for raiſing, removing, and delivering water, the trunk Fig. 6 is to be hung to the ſlot or piece of wood K in Fig. 1, inſtead of the other trunk; the rope on the barrel of the windlaſs, being looſened or unwound, will let the trunk down to the water; and then, on pulling by the hand, the rope paſſing over the roller M in Fig. 1, through the pulley on the ſide of the axis I in Fig. 1, and over the roller R in Fig. 6, and faſ-

tened

tened to the door at the bottom of the water-trunk, Fig. 6, will raife or open fuch door of the water-trunk, which will let in the water and fill the trunk; and then, by flackening the rope, the lead upon the door of the water-trunk will clofe it. Then, by winding the rope upon the wind-lafs, the end of the principal beam or lever, with the water-trunk hanging thereto, will be raifed and removed out of the river, canal, or fifhpond; when, by pulling the faid laft mentioned rope, the lid or door at the bottom of the water-trunk is raifed and opened, and the water therein let out or difcharged; then, by unwinding the rope on the windlafs, the water-trunk is let down again to the river, canal, or fifhpond, as before. In witnefs whereof, &c.

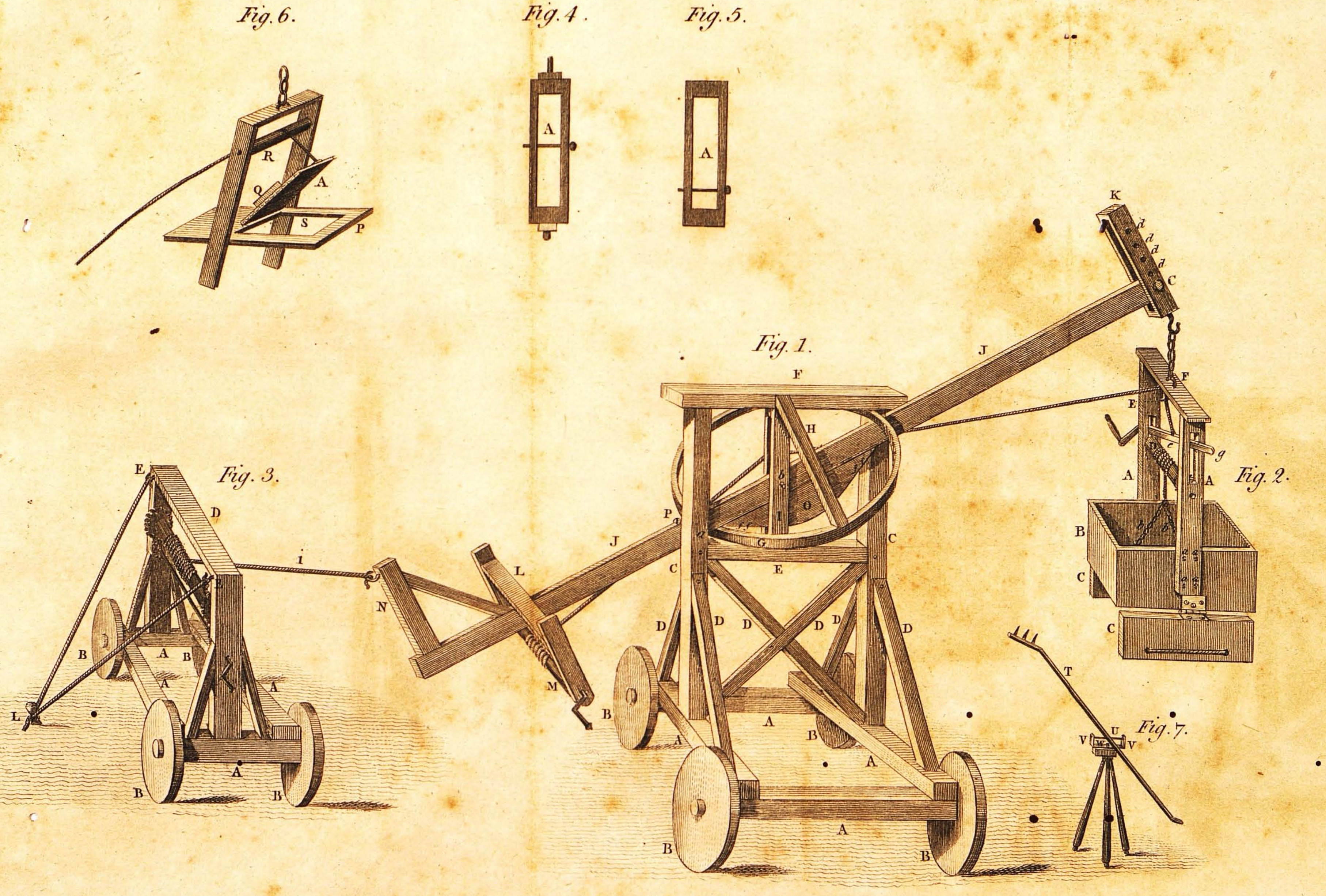


Fig. 6.
Fig. 4.
Fig. 5.
Fig. 1.
Fig. 2.
Fig. 3.
Fig. 7.

XII. *Specification of the Patent granted to Mr.* JOHN ATKINSON, *of Harrington, near Liverpool, Colour-Manufacturer; for making or manufacturing, from certain Materials, certain Colours or Paints, of a superior Quality to the Colours or Paints hitherto made from the same Materials.*

Dated June 18, 1794.

TO all to whom these presents shall come, &c. NOW KNOW YE, that I the said John Atkinson, in compliance with and conformity to the said proviso, do hereby particularly describe and ascertain the nature of my said invention as followeth; I do declare that the colours or paints of a superior quality to the colours or paints hitherto made from the same materials, whereof I have invented the making or manufacturing, as before mentioned, (and which materials are herein after mentioned and described,) are respectively

tively commonly called or known by the names or defcriptions of Venetian red, Spanifh brown, colcothar of vitriol, chocolate purple brown or purple brown, blue purple or dark purple brown, white or mineral white. And, firft, with regard to the making or manufacturing of the faid paint or colour called Venetian red, I do declare, that the material of which the faid Venetian red paint or colour is made, is precipitated ochre, or earth of iron, otherwife called crocus martis or faffron of Mars; and that the fame muft be diluted with water in an iron or other boiler or furnace, and fire or heat applied till the water and ochre boil, or attain a boiling heat; in which ftate it parts with moft of its ferruginous mixtures; and, after ftanding about five minutes, the heterogeneous particles will fall to the bottom of the boiler, and the finer parts muft be taken therefrom, and conveyed into a pan or receiver, or other veffel capable of bearing heat; and fire or heat muft be urged or applied till the whole is fufficiently dry; or the fame may be dried by the fun, or wind. In that ftate it muft be

be removed to a calcining-furnace or oven, commonly called a reverberatory-furnace, where, by the aſſiſtance of a bright flame conveyed over the top of it for about eight hours, the colour is changed from a yellow to a bright red colour; in which ſtate it muſt be drawn from the furnace or oven, and, when cold, muſt be ground by a mill or machine; regard being had to the colour being duly mixed with water. After which it muſt be conveyed from the mill or machine, by a plug about twelve inches from the bottom of the tub, into ſpouts which carry it into fine ſieves; whence it muſt be received into ciſterns or veſſels which communicate one with another by ſpouts, or otherwiſe, by which means the finer particles float into the farther part of the ciſterns. I make uſe of ſix ciſterns in number, but a greater or leſs number may be uſed; and in this ſtate, after ſtanding about twenty-four hours, the water is to be drawn from the colour, and then mixed with alabaſter and chalk, both finely ground; after which it muſt be dried. I uſe for that purpoſe a drying loft made with Venetian-blinds, which admit of

a current of air, and put the colour in earthen diſhes, about ten inches wide and four inches deep. The colour is then in the form of a cake, in which ſtate it is ſaleable; but, when it is ordered in powder, it muſt be finely ground. And, ſecondly, with regard to the making or manufacturing of the ſaid paint or colour called Spaniſh brown, I do declare, that the heterogeneous part of the ſaid precipitated ochre, earth of iron, material or reſiduum from the boiler, as deſcribed in the former proceſs for the making of Venetian red, muſt be taken to a reverberatory-furnace, where it muſt be calcined with a ſtrong heat for about ſix hours, together with a native ochre, commonly called yellow ochre; and at the end of that time its colour will be changed from a yellow to a dark red colour, in which ſtate it is to be taken from the furnace, and, when cold, ground by a mill or machine; regard being had to the colour being duly mixed with water. After which it muſt be conveyed from the mill or machine, by a plug about twelve inches from the bottom of the tub, into ſpouts which carry it into ſieves; whence it muſt

muſt be received into ciſterns or veſſels which communicate one with another by ſpouts, or otherwiſe, as deſcribed in the proceſs with reſpect to the making of the Venetian red. And, after the ſame has ſtood about twenty-four hours, the water muſt be drawn from it, and the colour removed to a pan or receiver, or other veſſel made of bricks, or other materials, capable of bearing heat; and, after being dried by fire, or otherwiſe, muſt be powdered for ſale. And, thirdly, with regard to the making or manufacturing of the ſaid paint or colour called colcothar of vitriol, I do declare, that the ſaid precipitated ochre or earth of iron, or material, muſt be put into a calcining-furnace, commonly called a reverberatory-furnace, and a very ſtrong fire conveyed over the top of it for about ſixteen hours, when the ſame will be changed from a yellow to a bright light purple; and in that ſtate it muſt be drawn from the furnace, and, when cold, muſt be ground by a mill or other machine; being duly mixed with water. After which it muſt be conveyed from the mill or machine, by a plug, into ſpouts which remove it to ſieves,

ſieves, and thence received into ciſterns or veſſels which communicate one with another, as deſcribed in the former proceſs; and, after the ſame has ſtood about twenty-four hours, the water muſt be drawn from it, and the colour collected and dried in the air, or otherwiſe; after which it muſt be powdered for ſale. And, fourthly, with regard to the making or manufacturing of the ſaid paint or colour called chocolate purple brown or purple brown, I do declare, that the material from which the ſame is to be made, is the ſlime of ſulphureous copper ore; and that the ſame is to be taken to a furnace, commonly called a reverberatory-furnace, and calcined for about eight hours, with a ſtrong fire conveyed over the top of it, at the end of which time the colour will be changed from a dark lead-colour to a dark chocolate-colour; in which ſtate it muſt be drawn from the furnace, and, when cold, muſt be ground by a mill or other machine; being duly mixed with water. After which it muſt be conveyed from the mill or machine, by a plug, into ſpouts which remove it to ſieves, and thence received into ciſterns

which

which communicate one with another, as described in the former proceſs; and, after having ſtood about twenty-four hours, the water is to be drawn from it, and the colour collected and dried by fire, or otherwiſe, and then powdered for ſale. And, fifthly, with regard to the making or manufacturing of the ſaid paint or colour called blue purple or dark purple brown, I do declare, that the ſame is to be made from the aforeſaid ſlime of ſulphureous copper ore; and that the ſame muſt be calcined in a furnace, commonly called a reverberatory-furnace, for about ſix hours; and, when cold, conveyed to a mill or machine, with a ſtone on edge, where it muſt be powdered. After which it muſt be brought back to the furnace, and expoſed a ſecond time, for about ſixteen hours, to a ſtrong fire conveyed over the top of the colour; at the end of which time the colour will be changed to a bright blue purple colour, or by ſome called dark purple brown; in which ſtate it muſt be drawn from the furnace, and, when cold, ground, and conveyed, and received into ciſterns or veſſels, in like manner as is herein before

before mentioned; and, after having ſtood about twenty-four hours, the water muſt be drawn from it, and the colour collected, and dried by fire, or otherwiſe, and powdered for ſale. And, laſtly, with regard to the making or manufacturing of the ſaid paint or colour called white or mineral white, and which is to be made from a certain material called the ore of blende, black jack, or lapis calaminaris; the ſame muſt be firſt calcined, after which it muſt be powdered and mixed with about an eighth part of its weight of powdered charcoal; the whole is then to be put into a jar or pot, with a pipe in the bottom, communicating with a reſervoir ſituated below the bottom of the furnace. The jar or pot, with its contents, are to be placed in a furnace ſimilar to a glaſs-houſe furnace; the jar and reſervoir being firſt duly luted. After which the whole muſt be expoſed to a very ſtrong fire for about five hours, in which time the metallic part of the ore, or zinc, will be collected in the reſervoir. The zinc is to be immerſed in vinegar, and expoſed to a gentle heat for about twelve days, at the end of which time

time it will be dissolved, and a white powder will fall down to the bottom, which must be collected and dried; after which the same must be mixed with about a tenth part of its weight of sulphur, and sublimed; and received into cisterns or vessels which communicate one with another, in like manner, in all respects, as described in the former process; and, after having stood about twenty-four hours, the water must be drawn from it, and the colour collected, and dried, and then powdered for sale. In witness whereof, &c.

XIII. *Specification of the Patent granted to Mr.* ROBERT GOLDING, *of the Parish of St. Olave, Southwark, Hat-dyer; for his Method of dying, staining, and colouring, Beaver and Beaver-Hats, Green, or any other Colour, &c.*

Dated Jan. 1. 1782.—Term expired.

TO all to whom these presents shall come, &c. NOW KNOW YE that, in compliance with the said proviso, I the said Robert Golding do hereby declare, that my said invention of a new method of dying, staining, and colouring, beaver and beaver-hats, commonly called felt, or beaver, or stuff hats, green, or any other colour, underneath or on one side only, preserving the natural colour on the other side, is described in the manner following; that is to say, first, the nap of the hat on the side intended to be dyed is to be raised with a card, then boiled in alum and argol;

argol; and afterwards a thin paſte, made of flour, or clay, ſpread with a painter's bruſh over every part of the hat not intended to be dyed; then cloſed; or they may be paſted firſt, and then, inſtead of being boiled, muſt be only ſimmered in the ſame liquor. As ſoon as the paſte, in either caſe, is ſpread, plates of copper, or any other metal, or thin boards, nearly of a triangular form, or an inſtrument of the ſame materials, ſhaped like a common funnel, are fixed over and upon the paſte, to prevent the dye coming through, and ſometimes paſted and cloſed together with plates or boards. Then a ſmall plate, with the initials of the dyer's name, is fixed or faſtened to that part of the hat intended for the inſide-crown, which admits ſuch initials being dyed therein at the time the hat is dyed. In this ſtate the hat is put into the dying-liquor, boiling or almoſt boiling, and remains there till the colour propoſed is ſufficiently fixed. It is afterwards taken out, opened, and cleanſed from the paſte, and, if any ſpots have got through, they are removed by being waſhed with a ſmall mop of

 linen

linen rags dipped in a ſtrong alkali infuſed in hot water; but, as a yellow ſpot, or iron-mould, will remain, ſuch ſpots are removed by waſhing them with a ſmall quantity of ſpirit of ſalt, aqua fortis, or vitriol, infuſed in cold water, and run out with a piece of board or ſtamper, made for the purpoſe of making the hats clean from the filth and water, after having been dyed and waſhed as aforeſaid. The compounds made uſe of in dying are, fuſtic, turmeric, ebony, weld, ſafflower, ſaffron, alum, argol, indigo, and vitriol, with chamber-lie, or pearl-aſh, at the option of the dyer, ſometimes all uſed together, ſometimes otherwiſe, according to the intention of the dyer, and to the colour required. In witneſs whereof, &c.

XIV. *On forming Oak-Trees into Compaſs-Shapes, for the Uſe of Ship-Builders.* By Mr. WILLIAM RANDALL, *of Maidſtone, Kent.*

WITH A PLATE.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

FROM the ſcarcity and very high value of compaſs-ſhape timbers, the enormous waſte in his Majeſty's yards, as well as loſs of time in cutting them out from large trees, when not to be had of a natural growth, excluſive of the delays occaſioned by the want of trees fit for that purpoſe, I have been led to conſider that the ſhape of a tree might be ſo altered, in its early growth, as to ſuit the different purpoſes. From the ineſtimable value of the object, and the extreme length of

of time which muſt elapſe before the full advantages of theſe improvements can be obtained, I was induced to make ſome trials, to prove what was likely to be effected.

By the figures annexed, (ſee Plate VI,) and from ſtrict obſervations on effects inadvertently produced from ſomewhat ſimilar cauſes, I have concluded that the deſign might be accompliſhed; and have taken the liberty of ſubmitting this paper to the ſuperior judgement of the Society, by whom more perfect plans may be formed, &c.

Rules for training Oak-Trees to Compaſs-Shapes, for Naval Purpoſes.

It may not be improper to remark, that moſt of the numerous families of timber-trees either produce their leaves and ſide-ſhoots alternately, or in pairs. In the firſt claſs is the oak, whoſe leading ſhoot frequently takes a reclining direction; yet, in proceſs of time, if it meet with no obſtructions, it becomes erect. Thoſe producing leaves and lateral ſhoots in pairs, as the aſh, maple, &c. ſeldom alter the poſition they firſt take.

It

It is found neceſſary, in the common practice of raiſing trees, (in order to keep them upright,) to leave all the lateral ſhoots entire, or cut to what are, in the nurſery-trade, termed ſpurs, from ſome diſtance below the head, eſpecially on all alternate-leaf trees; for when, by eagerneſs to accelerate the height of thoſe trees, unſkilful perſons cut cloſe all the ſide-ſhoots, it generally happens that (from the luxuriant growth of the leader, and the weight of its full-extended foliage) a bend in the ſtem is brought on, which every future ſhoot aſſiſts to increaſe, until a regular head is formed; which done, the leader will aſſume an upright direction, and frequently returns to be perpendicular over the root.

Theſe obſervations are, no doubt, well known to the Society, and to all other perſons acquainted with the growth of trees; yet, from every practical rule, and impartial ſurvey of effects inadvertently produced from ſimilar cauſes, they will be found fully applicable to the preſent caſe; namely, to reverſe the methods uſed to obtain ſtraight-ſtemmed trees, by taking off, twice every year,

in

in March and June, all the lateral ſhoots cloſe to the ſtem; beginning when about eight feet high, and continuing till twenty feet, or more. This will cauſe the oak-trees on which it is practiſed to nearly reſemble the form marked Fig. 1; (ſee Plate VI;) after which time, if left to nature, the ſtem will in its regular courſe aſſume, in an advanced age, a form ſomewhat like that marked Fig. 2. This part of the plan might be well adapted to parks, hedge-rows, and open plantations.

The next part may be extended to woods, where underwood is regularly cut every fifteen or twenty years, in many of which are numbers of clean young oaks. Wherever two kindly trees happen to grow ſo near that they can be brought (by pulling down the heads with a ſtick having a hook at one end) to reach each other, a ſtrong branch from each, towards the top, may be gently twiſted, (ſo as not to deſtroy its growing faculties,) and the trees joined together by ſuch twiſt, (as at *a*,) which will keep the ſtems in the poſition ſhewn in Fig. 3. It is, by referring to

common causes, to be concluded that each leader will pursue an upright course, which will cause the future appearance to resemble Fig. 4.

In either of the above-mentioned situations, where there are single trees that cannot be brought to join with others of the same kind, and the first plan not approved of, any species of tree might answer the purpose, by cutting it of the height required, and bringing the branch from the oak down to it, then fastening it by a noose, easily made by twisting the branch as before. (See Fig. 5.) In default of a neighbouring tree, a strong stake with a hooked end would endure three or four years, and answer the purpose of confining the tree: (see Fig. 6:) its future growth will be likely to incline upward, and in time to form a shape nearly as Fig. 7. None of these processes are expensive; the two last plans, I find, can be done in ten minutes each tree, and can be only a trifling obstruction to its growth. Their superior advantages will be found in woods, where, at the following fall, or any future period, those that fail to form so de-

firable a ſhape as in the opinion of a judicious wood-reef is neceſſary, may be taken down, with little difference between their value in that ſtate, and that they would have borne had they been left to a natural courſe.

From the age of eight to fourteen years, if free growers, or about the ſame number of feet in height, I find is the moſt convenient time to fix them, according to the different deſigns. The ſpring, before the leaf comes out, I alſo find the beſt ſeaſon for twiſting the branches, or making any reduction of them.

Fig 1
Fig 2.
Fig. 3.
Fig. 4.
Fig 5
Fig 6
Fig 7

XV. *Conclusion of Dr.* PEARSON'S *Experiments and Observations on a Kind of Steel called* Wootz, *&c.*

(FROM P. 61.)

THE phænomena during the dissolution of steel were the same as those last related, except such as obviously arose from mechanical differences in the substances to be dissolved; in particular, the quantity of insoluble black matter, of white sediment, and of green crystals, was apparently the same. But, with respect to the phænomena of the dissolution of iron, there was one material difference between it and the dissolution of wootz, and of steel, namely, that the liquor was not turbid and black, but clear, with a very small quantity of black matter upon its surface. It is, however, proper to state, that seemingly the same kind and quantity of white sediment, and green crystals, were produced as from the dissolution of wootz and steel.

I think it of conſequence alſo to notice, that the black matter appears in the greateſt quantity when about half, or three-fourths, of the matter is diſſolved; but after this period, although gaz be ſeparated in as great quantity as before, the black matter ſeems to diminiſh. Hence I was at firſt inclined to conclude, with Mr. Berthollet, that part of this black or carbonaceous matter was diſſolved by the gaz, but I think I ſhall prove, that no ſuch combination takes place; and I now conſider it to be moſt probable, that the diminution ariſes from the diſſolution of the laſt portions of adhering iron.

With reſpect to the quantities and nature of the gaz ſeparated in this experiment:

I. The quantity of it from each hundred grains of wootz, on trials at different times, was found to be from 78 to 84 ounce-meaſures: the mean quantity therefore was 81.

II. The gaz from each hundred grains of ſteel wire, after many trials, was found to be from 83 to 86 ounce-meaſures; the mean quantity therefore was 84½.

III. The

III. The gaz from each hundred grains of bright iron wire, by many trials with the ſame and different parcels of wire, was found to be from 86 to 88 ounce-meaſures: the mean quantity therefore was 87.

It is to be underſtood, that when the quantities of the different parcels of gaz were compared with one another, they were meaſured at the ſame temperature, and under the ſame degree of preſſure. It is likewiſe to be underſtood, that whenever the ſolutions of wootz, ſteel, and iron, were made at the ſame time, and under the ſame circumſtances, as far as known, there was uniformly a ſmaller bulk of gaz from wootz than from ſteel, and from ſteel than from iron.

The ſmell of the gaz from the above three ſubſtances was that of hydrogen gaz; but I thought that from wootz had a ſtronger and more offenſive ſmell than that from ſteel; and that from ſteel was more offenſive than that from iron.

I could perceive no difference in the kind of flame, and exploſion, between theſe three parcels of hydrogen gaz: they burned in the ſame manner as common hydrogen gaz from ſulphuric acid, iron, and water.

Portions

Portions of the above gazes, mixed with oxygen gaz, from oxide of manganefe, were burned in clofe veffels, by the electric fire, over lime-water. I could perceive no difference, in the combuftion, between the gazes from the above different fubftances, nor any difference in the gaz from the fame fubftance at different ftages of the diffolution. I did not perceive the lime-water to be at all difturbed in its tranfparency, on my firft trials; but, in fubfequent ones, on viewing it more attentively, and in a good light, it was perceived to be very flightly turbid. It was equally fo with all the parcels of gaz.

To fatisfy myfelf farther, at the time I made thefe experiments, I exploded the mixture of inflammable gaz, obtained by decompounding water with white-hot charcoal of wood, with oxygen gaz; by which the lime-water was rendered quite milky. This inflammable gaz burnt very flowly, affording a deep blue lambent flame.

To determine the quantity, and afcertain the nature, of the undiffolved black matter in this experiment, I poured the folutions, while boiling hot, upon filtres of three folds of paper, and freed the

the filtres from the adhering ſolutions, by pouring boiling water upon them. The paper was ſtained black, by the ſolutions of wootz and ſteel, as far as the liquid reached; but the paper was only ſtained black at the apex of the cone of the filtre by the ſolution of iron. The quantity of black matter on the filtres, from the two former ſolutions, was apparently ſix or eight times more than from the ſolution of iron; but it adhered too firmly, and was in too ſmall a quantity, to determine the proportion accurately by weight. I eſtimated the quantity of the black matter to be one *per cent*. of the ſteel and wootz, and a proportionally ſmaller quantity from the iron. On account of the very black and turbid appearance during the diſſolution of wootz and ſteel, I was much ſurprized by the ſmallneſs of the quantity of black matter on the filtres; nor could I, by experiment, find that any of it paſſed through the filtres with the ſolutions.

This black matter being ſprinkled upon boiling nitre, a deflagration took place, and a large proportion of reſidue was found, and aſcertained to be oxide of iron. The black matter was there-

fore

fore a compound of iron and carbon, or, as ſome chemiſts term it, plumbago; and which, in the new ſyſtem, is denominated a carburet of iron.

I eſtimate the quantity of carbon in wootz and ſteel to be nearly equal; and that quantity to be about one third of a hundredth part, or $\frac{1}{300}$, of the weight of thoſe two ſubſtances.

I am, in the next place, to give an account of the ſolutions juſt mentioned of wootz, ſteel, and iron. On ſtanding, it has been obſerved, there was a depoſition of white matter, and formation of green cryſtals in a liquid.

The liquid, being decanted, was examined, and found to be ſulfate of iron, and ſuperabundant diluted ſulphuric acid.

The green cryſtals were obviouſly thoſe of ſulfate of iron.

The white matter I ſuppoſed was the *ſiderite* of Bergman, which is now believed to be phoſphate of iron. I made many experiments to aſcertain its nature; but it is only neceſſary to ſtate, that it readily diſſolved in hot water, and the ſolution afforded nothing but cryſtals of ſulfate of iron. Theſe cryſtals, by diſſolving in a little water, and by

boiling

boiling to leave behind water inſufficient for cryſtalization, yielded, on cooling, a white ſediment as before.

This white matter yielded colcothar, (a red oxide of iron,) by applying the flame with the blowpipe. The white matter therefore was not *ſiderite*, but ſulfate of iron, which could not cryſtalize on account of deficiency of water.

§. 7. *Experiments with oxide of Wootz, of Steel, and of Iron.*

1200 grains of wootz, diſſolved by diluted ſulphuric acid, and then precipitated from this acid by potaſh, yielded a greeniſh oxide; which, on drying in a ſtove, became a reddiſh-brown light powder, weighing 2700 grains; and by ignition it was reduced to 2000 grains.

300 grains of this oxide were made into a paſte with linſeed-oil; which, being wrapped in paper, was put into a crucible, and expoſed for near an hour to a fierce fire in the wind-furnace. On cooling, a cake of metal, weighing 200

 grains,

grains, was obtained, which had the eſſential properties of ſteel. The pyrometer denoted 150° of fire.

The reſult was the ſame on treating oxide of ſteel, and of iron, in the ſame manner as that of wootz.

Concluſions.

Many of the properties of wootz, related in the preceding experiments and obſervations, are ſo generally known to be thoſe of the metallic ſtate of iron, that, but for the ſake of order, I ſhould think it ſuperfluous to refer to any of them particularly, to ſupport the concluſion that wootz is at leaſt principally iron. Wootz is proved to be iron by its obvious properties; (§. 2.) by its filings being attracted by the magnet; (§. 2.) by its ſpecific gravity; (§. 2.) by its affording nothing but ſulfate of iron, hydrogen gaz, and a trifling reſidue, on ſolution in diluted ſulphuric acid. (§. 6.)

With regard to the particular ſtate of iron called wootz, I think I cannot explain its nature ſatiſ-

ſatisfactorily, without firſt relating the properties, and explaining the interior ſtructure, of the principal different metallic ſtates of iron. I imagine I ſhall be beſt able to execute this deſign, by ſtating preciſely the juſt meaning of the terms which denote, commonly, the three principal metallic ſtates of iron, namely, *wrought or forged iron*; *ſteel*; and *caſt or raw iron.*

I. *Wrought or forged iron* I underſtand to be that which poſſeſſes the following properties.

a. It is malleable and ductile in every temperature; and, the more readily, the higher the temperature.

b. It is ſuſceptible of but little induration (and if pure it is moſt probably ſuſceptible of none at all) by immerſing it, when ignited, in a cold medium, as in water, fat, oil, mercury, &c. Nor is it, on the contrary, ſuſceptible of emollition by igniting, and letting the fire be ſeparated from it very gradually.

c. It cannot be melted without addition; but it may be rendered quite ſoft by fire, and, in that ſoft ſtate, it is very tough and malleable.

d. It can eaſily be reduced to filings.

e. By being ſurrounded with carbon for a ſufficient length of time, at a due temperature, it becomes ſteel.

f. It does not become black upon its ſurface, but equally brown, by being wetted with liquid muriatic, and other acids.

g. By ſolution in ſulphuric, and other acids, it affords a reſidue of leſs than $\frac{1}{310}$ of its weight of carbon; and, if it could be obtained quite pure, there is no good reaſon to ſuppoſe there would be any reſidue at all.

II. *Steel* I underſtand to be that which has the following properties.

a. It is already, or may be rendered, ſo hard by immerſion, when ignited, in a cold medium, as to be unmalleable in the cold; to be brittle, and to perfectly reſiſt the file; alſo to cut glaſs, and afford ſparks of fire on colliſion with flint.

b. In its hardened ſtate, it may be rendered ſofter in various degrees, (ſo as to be malleable and ductile in the cold,) by ignition and cooling very gradually.

c. It requires upwards of 130° of fire, of the ſcale of Wedgwood's pyrometer, to melt it.

d. Whether

d. Whether it has been hardened or not, it is malleable when ignited to certain degrees; but, when ignited to be white, perfectly pure ſteel is ſcarcely malleable.

e. It becomes black on its poliſhed ſurface, by being wetted with acids.

f. Much thinner and more elaſtic plates can be made of it, by hammering, than of iron.

g. The ſpecific gravity of ſteel which has been melted, and hammered, is in general greater than that of forged iron.

h. With the aid of ſulphuric acid it decompounds a ſmaller quantity of water than an equal weight of forged iron.

i. It decompounds water, in the cold, more ſlowly than forged iron.

k. By repeated ignition in a rather open veſſel, and by hammering, it becomes wrought or forged iron.

l. It affords a reſidue of at leaſt $\frac{1}{300}$ of its weight of carbon, on diſſolution in diluted ſulphuric acid.

m. It is more ſonorous than forged iron.

n. On quenching in cold water, when ignited, it retains about $\frac{2}{3}$ of the extenſion produced by ignition;

ignition; whereas wrought iron, ſo treated, returns to nearly its former magnitude.

III. By the term *caſt* or *raw iron*, I underſtand that kind of iron which poſſeſſes the following properties.

a. It is ſcarcely malleable at any temperature.

b. It is commonly ſo hard as to reſiſt, totally or very conſiderably, the file.

c. It is not ſuſceptible of being hardened or ſoftened, or but in a ſlight degree, by ignition and cooling.

d. It is very brittle, even after it has been attempted to be ſoftened by ignition and cooling gradually.

e. It is fuſible, in a cloſe veſſel, at about 130° of Wedgwood's pyrometer.

f. With ſulphuric acid it generally decompounds a ſmaller quantity of water than an equal weight of ſteel.

g. It decompounds water, in the cold, more ſlowly than wrought iron.

h. It unites to oxygen of oxygen gaz as ſlowly, or more ſlowly, even than ſteel.

i. By ſolution in ſulphuric and other acids, it leaves a reſidue, not only of carbon, but of earth, which

which exceeds the quantity of refidue from an equal weight of fteel.

k. It is perhaps more fonorous than fteel.

With refpect to interior ftructure:

I. Wrought *Iron* is to be confidered as a fimple or undecompounded body; but it has not been hitherto manufactured quite free from carbon, which is to be reckoned an impurity.

The leaft impure iron, as indicated by properties, is that which poffeffes the greateft foftnefs, toughnefs, and ftrength; but if it be foft, independent of combination, it will of courfe be of the tougheft and ftrongeft quality. To denominate it from properties, I would call it *foft malleable iron:* and from internal ftructure, it fhould be called *iron*, or *pure iron*.

The ore from the deep mines of Dannemora produces the pureft iron. It is in England called *Oeregrund iron* *. It is almoft the only iron ma-

* Oeregrund is not the name of the country in which the ore of this iron is gotten; or of the place where it is manufactured; but it is the name of a fea-port town, from which the iron of Dannemora was formerly exported.

nufactured

nufactured which by cementation affords what our artiſts reckon good ſteel.

II. *Steel* has compoſition. It is a compound of iron and carbon, the proportions of which have not been accurately determined, but may be eſtimated to be one of carbon, and 300 of iron. I would call this ſtate of iron, from external properties, *hard malleable iron*: and from interior ſtructure and compoſition it may be called, as in the new ſyſtem, *carburet of iron.*

Steel of the beſt imaginable kind is ſuch as has not yet been manufactured; or it is that which has the moſt extenſive range of degrees of hardneſs or temper; the greateſt ſtrength, malleability, ductility, and elaſticity; which has the greateſt compactneſs or ſpecific gravity, and which takes the fineſt poliſh; and laſtly, which poſſeſſes theſe qualities equally in every part. Steel made by cementation, of the beſt quality, which has been melted, approximates the neareſt to this kind of ſteel. Its greateſt defect is want of malleability.

III. *Crude* or *raw iron* is a mixture, and has compoſition. It conſiſts of pure iron, united and mixed with other ſubſtances, ſo as to be hard un-

malleable

malleable iron: but the ſubſtances with which it is almoſt always mixed and united are three, viz. oxygen, carbon, and earth. I would term this ſtate of iron, on account of external properties, *hard unmalleable iron*; and, on account of ſtructure, *impure iron.*

In this ſtatement of inferior ſtructure of the different ſtates of iron, I have not thought it neceſſary to reckon the impalpable fluids which they contain, in perhaps different proportions; *viz.* light, caloric, electric, and magnetic fluids; for I believe their chemical agency has not been aſcertained.

Iron may alſo contain a much greater quantity of carbon than has been above ſtated to be a conſtituent part of ſteel; and this ſtate of iron is hard, unmalleable, and is not uniform in its texture. It may be called, according to the new nomenclature, *hyper-carburet of iron.* It is liable to be produced by cementing iron in a very high temperature, for a very long time, with a large quantity of carbon; and it is alſo produced by melting iron, or ſteel, with carbon.

 There

There are innumerable varieties of the firſt explained ſtate of iron, viz. *wrought iron.* Some of theſe are familiarly known, and diſtinguiſhed by names among artiſts. Different quantities of carbon, which is here an impurity, are the occaſion of theſe varieties; but, as the carbon is not in ſufficient quantity to diminiſh the toughneſs, ſoftneſs, and malleability, to ſuch a degree as to produce the obvious qualities of ſteel, ſuch varieties are reckoned to be thoſe of wrought iron. The carbon may, however, be in ſuch proportion as to produce a ſtate of iron which, in ſome degree, poſſeſſes the properties both of ſteel and wrought iron; and which poſſeſſes partly the properties of ſteel, and partly the properties of wrought iron. It is quite arbitrary to call ſuch kinds of iron, ſteel, or wrought iron.

There are alſo innumerable varieties of the ſecond ſtate of iron explained, *viz. ſteel.* Some of theſe are known, and diſtinguiſhed by artiſts. A greater, or ſmaller, proportion of carbon, than the quantity requiſite to ſaturate the iron, is the cauſe of theſe varieties; which are reckoned varieties

rieties of ſteel, becauſe they poſſeſs, in certain degrees, the diſtinguiſhing properties of ſteel.

Beſides theſe varieties of iron and ſteel, depending upon carbon, there are other varieties, from extraneous ſubſtances of a different nature. Theſe are moſt frequently oxide of iron, or oxygen, and ſilica; eſpecially in ſteel from the ore. The preſence of phoſphoric acid has been ſhewn to be the occaſion of the variety of iron named *cold ſhort*, which is brittle when cold, but not when ignited. And there is another variety, called *red ſhort*, which is malleable when cold, but brittle when ignited; the cauſe of which is ſuppoſed to be arſenic.

Iron and ſteel may contain an extraneous ſubſtance, and yet poſſeſs the properties of good, or even of the beſt, kinds of theſe metals. This is the caſe when they contain manganeſe; as the fine experiments of Profeſſor Gadolin, made under the direction of Bergman, have demonſtrated.

Some ſtates of iron are what are called mechanical mixtures of ſteel and wrought iron. This is, more or leſs, always the caſe with *bar ſteel* made

by cementation: if the bar be thick, the interior part will be mere iron.

Laſtly: There are different ſorts of ſteel, and of wrought iron, fron the difference of mechanical arrangement of their parts. Thus the ſpecific gravity of ſteel, by cementation, may be increaſed by fuſion, or hammering, and its grain altered. I have been told, that it may be hammered, in the cold, till it is ſo brittle that a ſlight ſtroke will break a thick bar. By quenching cloſe-grained hammered ſteel in cold water, when ignited to whiteneſs, its ſpecific gravity is diminiſhed, its grain is opened, and it is rendered much harder.

Theſe diſtinctions will perhaps ſerve to explain the nature of many varieties of the different ſtates of iron, differently named by artizans; namely, *pig-iron*; *charcoal*, and *coal-pig*, or *ſow-iron*; *blue, grey, white, caſt iron*; *ſoft iron*; *tough iron*; *brittle iron*; *hard iron*; *ore ſteel*; *cement ſteel*; *bliſter ſteel*; *ſoft ſteel*; *hard ſteel*; *hammered ſteel*; *caſt ſteel*; *burnt ſteel*; *over-cemented-ſteel*.

I ſhall

I ſhall next endeavour to ſhew to which of the above ſtates of iron wootz is to be referred, or to which of them it moſt approximates.

It appears that wootz is not at all malleable when cold; and when ignited it is difficultly forged, and only in certain degrees of fire. It can be tempered and diſtempered, but not to a conſiderable extent of degrees. (§. 3. *e f.*) The range of degrees of fire at which it is forged is of leſs extent (§. 3. and §. 3. *b.*) than the degrees at which it can be tempered. (§. 3. and §. 3. *e f.*) It vies with the fineſt ſteel in its poliſh. Its ſpecific gravity, which is leſs than that of hammered iron, is very little diminiſhed by ignition and cooling rapidly. (§. 2. N°. 6.) It melts, but at a higher temperature then crude iron. (§. 3. *h i.*) It is not eaſily reduced into filings, even after annealing. (§. 3. *f.*) Its poliſhed ſurface grows black by being wetted with nitrous acid. (§. 5. *e.*) It is not ſo brittle as raw iron, nor even as ſteel. (§. 2.) On ſolution in ſulphuric acid and water, it affords about the ſame quantity of carbon as ſteel, and rather leſs hydrogen gaz. (§. 6.)

From

From theſe and other properties, related in the preceding experiments and obſervations, it is evident that wootz approaches nearer to the ſtate of ſteel than of raw iron; although it poſſeſſes ſome properties of this laſt ſubſtance.

With regard to the kind of ſteel to which wootz is to be referred; it is not of that ſort in which there is either an exceſs or deficiency of carbon, (page 121, line 14, *et ſeq.*) but it muſt contain ſomething beſides carbon and iron, otherwiſe it would be common ſteel. It appears that the ſolution in nitrous acid, (§. 5.) and in diluted ſulphuric acid, (§. 6.) contained only oxide of iron, and a reſidue of carbonaceous matter, as in common ſteel. Hence it is obvious to ſuſpect that wootz contains oxygen, either equally united with every part of the maſs, or united with a portion of iron to compoſe oxide, which is diffuſed throughout the maſs. That this is really the ingredient in wootz which diſtinguiſhes it from ſteel, ſeems to be proved, or at leaſt conſiſts with its properties. For, it accounts for the ſmaller quantity of hydrogen gaz than was afforded by common ſteel, (§. 6.) it accounts for the partial fuſion; (§. 3. *h.*) it ac-

counts

counts for the great hardneſs, even on reducing its temper; (§. 3. *f*.) for its little malleability; (§. 3.) and perhaps it is the reaſon of the fine edge, and poliſh. (§. 2. §. 3.) The experiments (§.3. *g h*.) confirm this concluſion. The oxide is perhaps not equally diffuſed; hence the wootz is not quite uniform in its texture and hardneſs, until it has been remelted. (§. 3. *b*.) The brittleneſs of wootz when white hot (§. 3. *b*.) is a property of caſt ſteel; and ſhews that it contains no veins or particles of wrought iron, and alſo that it has been melted. Common ſteel, which is all made by cementation, is very malleable when white hot, only perhaps becauſe it contains iron which has eſcaped combination with carbon.

The proportion of oxygen in wootz muſt be very ſmall, otherwiſe it would not poſſeſs ſo much ſtrength, and break with ſo much difficulty, (§. 2.) and much more oxide would have melted out. (§. 3. *g*.) This oozing out of matter is analogous to that which appears on refining raw iron.

Although no account is given by Dr. Scott of the proceſs for making wootz, we may, without

 much

much riſk, conclude that it is made directly from the ore, and conſequently, that it has never been in the ſtate of wrought iron. For, the cake is evidently a maſs which has been fuſed; (§. 2.) and the grain (§. 2.) of the fracture is what I have never ſeen in cement-ſteel, before it is hammered or melted. This opinion conſiſts with the compoſition of wootz; for, it is obvious that a ſmall portion of oxide of iron might eſcape metallization, and be melted with the reſt of the matter. The cakes appear to have been cut almoſt quite through, while white hot, (§. 2.) at the place where wootz is manufactured; and, as it is not probable that it is then plunged in cold water, the great hardneſs of the pieces imported, above that of our ſteel, muſt be imputed to its containing oxide, and conſequently oxygen.

The particular uſes to which wootz may be applied may be inferred from the preceding account of its properties and compoſition; they will alſo be diſcovered by an extenſive trial of it in the innumerable arts which require iron.

XVI.

XVI. *On the Purification of crude Saltpetre.* *By M.* Baumé.

FROM THE *ANNALES DE CHIMIE.*

THE name of crude ſaltpetre is given to that which is procured by lixiviating the earths which contain it. Potaſh is added to the lie, to decompoſe thoſe ſalts which have an earthy baſis. Crude ſaltpetre is a mixture of nitre with a baſis of fixed alkali; of nitre with an earthy baſis; of three kinds of ſea-ſalt, one with a baſis of mineral alkali, another with a baſis of fixed vegetable alkali, and the third with an earthy baſis; of a ſmall quantity of ſelenite; of a ſmall quantity of earth, in two different ſtates, being partly looſe, and partly diſſolved by thoſe ſalts which form what is called the mother-water; and, laſtly, of a certain quantity of extractive vegetable and animal matter. Sometimes crude ſaltpetre alſo contains a ſmall portion of ſal-ammoniac.

The object, in the purification of ſaltpetre, is to ſeparate from it all foreign ſubſtances. In the laboratories belonging to government, (which, according to law, are the only places were ſaltpetre can be purified,) the crude ſaltpetre undergoes two diſſolutions, and two ſucceſſive cryſtalizations. To the firſt ſolution a certain quantity of Flanders glue is added, to clarify the liquor; this is an additional trouble in the operation, and is quite uſeleſs in the proceſs I am about to propoſe. The following is a ſhort account of the common method of purifying crude ſaltpetre.

Five or ſix thouſand pounds of crude ſaltpetre are put into a copper caldron, with about an equal quantity of water. The mixture is heated, and, on account of the ſmall quantity of water, the ſaltpetre is diſſolved by help of the heat, in preference to the ſea-ſalt; but ſome ſea-ſalt is alſo diſſolved; the reſt is taken away with a great ſkimmer. The ſalt is put to drain in a baſket, placed over the caldron; and the liquor is then clarified with a pound or two of Flanders glue diſſolved in water. A ſcum is formed, which contains the looſe earth; this ſcum is taken away as it

riſes.

rifes. The liquor is then put into large copper veffels, in which it cryftalizes. The cryftals produced are fet to drain; they are impure, as they contain a portion of fea-falt, and alfo a portion of the mother-water in which they cryftalized.

This impure faltpetre is purified by diffolving it again in water, and cryftalizing it, as was done before. The cryftals arifing from the fecond cryftalization are called purified falt-petre, and are ufed for making gunpowder, &c. The mother-water, from the various cryftalizations, is collected together, and is afterwards purified, by itfelf, by means of potafh.

The above is a fhort view of the manner of refining or purifying faltpetre, as it has been practifed for time immemorial. A quantity of mother-water, and of fea-falt, remain, as we have feen, mixed with the falt-petre of the firft cryftalination. Thefe foreign fubftances, though in a lefs proportion, ftill remain mixed with the falt-petre of the fecond cryftalization; and the liquor feparated from the faltpetre of the fecond cryftalization, by being evaporated afrefh, forms only

ſuch ſaltpetre as is formed by the firſt cryſtalization, on account of the mother-water and ſea-ſalt mixed with it.

I do not think it neceſſary to be more particular reſpecting this operation, as it is deſcribed in almoſt every book on chymiſtry; what I have mentioned will ſerve to bring it into view, ſo that it may be compared with the proceſs I am going to propoſe. It is ſufficient to remember that, in the old proceſs, the crude ſaltpetre undergoes two ſucceſſive diſſolutions and cryſtalizations; and the mother-water is operated upon by itſelf.

The proceſs I propoſe is more ſimple; by it is obtained, without fire, without diſſolution, without any clarification, with leſs labour, leſs expence, and at one ſingle operation, as much ſaltpetre, and as pure as that of the ſecond cryſtalization. The mother-water is collected and purified by itſelf, as uſual; but, as I ſeparate it, and alſo the ſea-ſalt, at the beginning of the operation, the ſaltpetre is not accompanied through the whole proceſs (as in the other way) by ſub-

ſtances

ſtances which do not belong to it, conſequently there is no ſuch impediment to its purification.

I propoſed this method, in the year 1788, to the arſenal. Some experiments were tried, but not properly purſued, becauſe it was thought that my proceſs would cauſe too great a change in the uſual courſe of things; I can, however, aſſert that it required no changes but ſuch as are ſtrictly œconomical.

I ought to mention, that I made my experiments only upon one hundred ounces of crude ſaltpetre at a time; that quantity is certainly very ſmall, compared with what would be operated upon at once in the large way; but there is no reaſon why my proceſs (which is founded upon the diſpoſition which cold water has to diſſolve the ſea-ſalt, and the mother-water, in preference to the ſaltpetre) may not be practiſed, at once, upon whatever quantity of crude ſaltpetre may be thought neceſſary.

Analyſis of one Hundred Ounces of crude Saltpetre.

I took, for my experiments, a crude ſaltpetre upon which the loſs, by the uſual proceſs, was about thirty *per cent.*

I put one hundred ounces of this ſaltpetre into a large glaſs receiver, with ſixteen ounces of cold river-water; I left this mixture in infuſion for the ſpace of half an hour, ſhaking it often. I then put it to drain in a large glaſs funnel, till no more liquor would drop from it; the ſpout of the funnel had a ſmall bundle of ſtraw in it, to retain the ſaltpetre. By this firſt operation I got rid of almoſt all the mother-water, and of a ſmall quantity of the ſea-ſalt.

I put the ſaltpetre again into the ſame glaſs receiver, with a pint of cold river-water; I let this mixture remain for the ſpace of twenty-four hours, taking care to ſhake it often, to facilitate the diſſolution of the ſea-ſalt; at the end of that time, I ſet it to drain as before.

When

When it had thoroughly drained, I mixed it again, for the third time, with another pint of cold river-water; I left this mixture in infusion as before, during twenty-four hours, and then set it to drain. When it had drained, I sprinkled it with cold water several times, that it might be completely washed. The saltpetre had now a beautiful appearance, was very white, and nearly as pure as that which has been twice crystalized.

By the above simple process, without dissolution, I can obtain, whenever I please, saltpetre more pure than it often is after being twice crystalized. But, as the saltpetre which is to be used in making gunpowder ought to be not only very pure, but also intirely free from gravel or small stones, it is necessary that such saltpetre should be purified by dissolution, and that the liquor should be passed through a cloth before it is crystalized. For these reasons it is needless to purify the saltpetre completely by washing.

The saltpetre washed, as above described, and well drained, weighed sixty ounces. I dissolved it, with the assistance of heat, in five pounds of water;

water; and then filtered the liquor. The earth remained upon the filtre; I washed it, and dried it; it then weighed forty-eight grains. By two crystalizations I obtained fifty-one ounces, four *gros*, and nine grains of saltpetre, which was perfectly pure; it scarcely rendered a solution of silver turbid, and was, in short, as good as that which is prepared at the arsenal for the fabrication of the best kind of gunpowder. There remained about eight ounces of liquor which I mixed with the mother-water, that I might operate upon them together, in the manner I shall hereafter describe.

Thus, from one hundred ounces of crude saltpetre, I obtained nearly three quarters of the original quantity, of very pure saltpetre, by one simple purification.

In the usual way of purifying saltpetre there also remains a great quantity of saltpetre in the first separated mother-waters; which is procured from them afterwards, by operations which perhaps require to be examined. At present I shall nor offer any thing new on this head; but shall

only

only obſerve that, according to the proceſs I propoſe, the mother-water is ſeparated by the firſt waſhing, and may be treated by itſelf with pot-aſh, in the common manner. From the water of the ſecond and third waſhings, evaporated together, ſaltpetre of an inferior quality may be obtained.

Crude ſaltpetre, as I have already obſerved, contains a ſmall quantity of earth. This earth is in two different ſtates; a part of it is looſe, and may be ſeparated, almoſt intirely, during the waſhing of the ſaltpetre. For this purpoſe it is ſufficient to take the ſaltpetre out of the veſſel in which it is waſhed, with a ſkimmer, and to put it to drain. The ſolution of the ſaltpetre ſo treated does not grow turbid during its evaporation.

The other part of the earth is kept in ſolution by the mother-water; it ſeparates, by degrees, every time the liquor is evaporated.

TO BE CONCLUDED IN OUR NEXT.

XVII. *On the Means of preserving those who are employed in grinding Colours from the Disorders occasioned by that Employment.* By M. BOULARD, *of Lyons, Architect.*

WITH A PLATE.

FROM THE *JOURNAL DE PHYSIQUE*

IT is well known that many substances emit exhalations which are dangerous to health; but, if we do not breathe the air with which they are mixed, or if there exists a wind which carries those exhalations away from us, we cannot have any thing to fear from them. If, therefore, the workman who grinds colours does not breathe the air in which they are situated, or if we can keep up a constant current of wind, which shall carry off the vapours arising from those colours, they cannot possibly do any harm to the workman; it being the air we breathe which serves as a vehicle to convey these noxious

vapours into our bodies. Theſe principles are certain and inconteſtible.

To produce the ſalutary effects above mentioned, I ſurround the table A, (Plate VII,) and the ſtone on which the colours are ground B, with a caſe C C; this caſe is open at top *, and is ſo much larger in its dimenſions than the ſtone, as to leave a ſmall interval, of about $\frac{1}{16}$ of an inch, all round it; the upper edge of the caſe is nearly on a level with the ſurface of the ſtone. Through one of the ſides of the caſe paſſes a pipe D, which has a communication with the external air, by going through the floor, or one of the walls. About ſix inches above the ſtone is a kind of hollow pyramid E, formed of four glazed frames, which are ſo wide as to extend about three inches beyond the edge of the ſtone. The pyramid is terminated by an iron pipe or funnel F, which communicates with a furnace G, which draws in its air from the bottom, and finiſhes at top in a pipe, which ſerves as a chimney. When a fire is lighted in the furnace, the air contained under

* In the plate one of the ſides is taken away, to ſhew the internal conſtruction.

the pyramid will aſcend; this air will ſoon be replaced by the external air, which, paſſing through the caſe, will keep conſtantly riſing all round the ſtone, (by the interval between it and the caſe,) and thence into the pyramid. This current, being once eſtabliſhed, will confine, as much as poſſible, the vapours ariſing from the colours, and will convey them away, ſo that the workman will be no longer expoſed to their dangerous effects.

This ſimple contrivance appears to me unobjectionable, as it preſents no obſtacle to the labour of the workman, who may ſee his work through the glazed frame, and may ſcrape together his colour as often as he thinks proper. If the ſtone ſhould be too large, ſo that the pyramid is in the way of his arms, he may leſſen that inconvenience by walking round the ſtone as he works.

In order that the furnace may produce its effects properly, the doors of it muſt be cloſe ſhut, and the room in which this contrivance is placed muſt be only of a middling ſize, and well cloſed. The ſmall quantity of air which will come in,

through

through the interſtices of the doors and windows, will do no harm; on the contrary, as it will be drawn under the pyramid, it will carry off thoſe vapours which the workman, by the motion of his arm, may have cauſed to eſcape.

I have tried the effect of the contrivance I propoſe; and found that, by means of as much charcoal as ſerved me to fill the furnace twice, I could grind verdegris, (a colour which furniſhes the moſt dangerous vapours, and the moſt offenſive ſmell,) for the ſpace of three hours, without the ſmalleſt inconvenience. Several very delicate perſons, who came into the room during the operation, aſſured me that they did not perceive any diſagreeable ſmell, and that the contrivance appeared to them to anſwer the end propoſed in the moſt complete manner.

I afterwards made the following experiment. To render the current of air which riſes around the grinding-ſtone perceptible, I put into the wooden caſe, under the ſtone, a chafing-diſh with a ſmall fire in it, on which I threw ſome powdered ſugar. A thick ſmoke aroſe round the ſtone; and was perceived to paſs rapidly into the pyramid,

pyramid, being drawn that way by the current of air which paſſed through the furnace. This current of air and ſmoke was ſo rapid, that I could by no means alter its courſe, or direct it to the outſide of the pyramid.

The ſucceſs of the forementioned experiments convinced me of the advantages of this contrivance. In the firſt place, it is very ſimple, and defends the workman from danger, without making any alteration in the uſual manner of grinding colours; it alſo carries off the dangerous vapours without rendering the work more difficult, the workman (as was before obſerved) being able to ſcrape the colours together, as often, and as eaſily, as in the common way of working. Secondly, this contrivance may, at a very ſmall expence, be adopted by all perſons who grind colours; the expence of grinding them will be very little increaſed by it, as a ſmall quantity of charcoal is ſufficient; and the expence of that might be diminiſhed, or taken away, by making the furnace ſerve alſo for other uſes. It might be uſed for the purpoſe of boiling oils to mix with colours, and the workman who is employed in grinding

could,

could, at the ſame time, attend to the oils which are to be boiled.

I muſt obſerve, that if the furnace is to be uſed for theſe various operations, it ſhould be placed near the ground; it will not, on that account, act with leſs effect on the pyramid, provided the pipe of communication, proceeding from it, is bent in a proper manner.

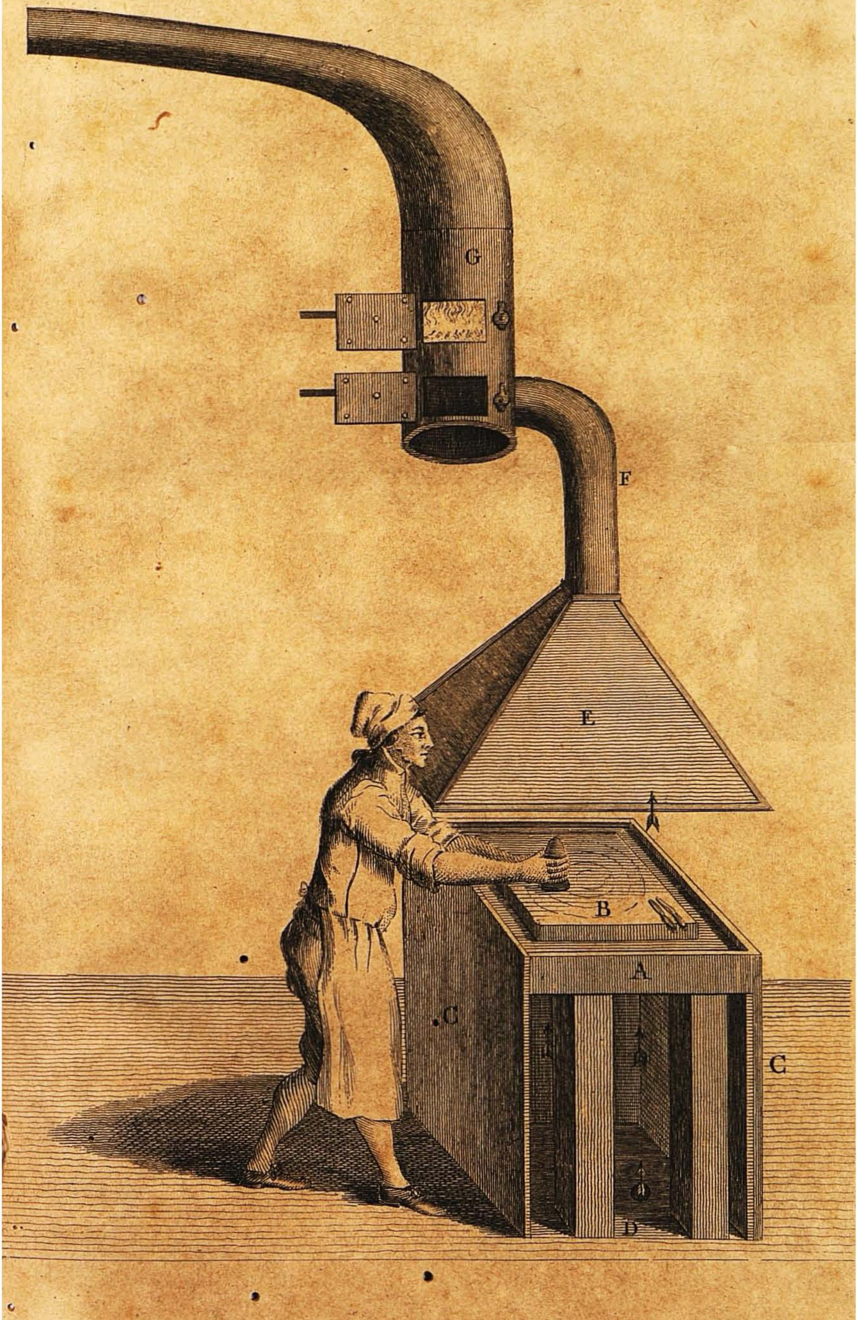
I ſee but one reaſonable objection to what I have here propoſed. It may be ſaid, that in ſummer the furnace may occaſion a degree of heat in the room which may be very diſagreeable; or (admitting that not to happen) the furnace may not occaſion ſo ſtrong a current of air at that ſeaſon of the year as at others.

The firſt part of this objection I conſider as abſolutely void of foundation; a very ſmall quantity of fuel ſerves to keep up the fire, the heat from which is mild and temperate, and much leſs than that in which many workmen are obliged to perform their reſpective operations. But, were it greater, an increaſe of heat would ſurely be leſs dangerous than the vapours ariſing from many colours.

With

With reſpect to the current of air in ſummer, I have reaſon to think it would always be ſuffi-cient to produce the deſired effect. If it ſhould not, I propoſe to employ, inſtead of the furnace, two pair of ſingle bellows, of a middling ſize, which a child might work by means of a beam or lever. Theſe bellows ſhould be placed oppoſite each other, and near the floor; their lower parts ſhould be firmly fixed, and motionleſs, and their upper parts ſhould be moved by rods connected with the lever. The tube of the pyramid ſhould be divided into two branches, which branches ſhould communicate with the bellows; the nozles of which ſhould be larger than uſual. Thus the air, loaded with the vapours from the colours, might be driven into a chimney, or any other place where it might be diſperſed without danger.

Inſtead of the bellows, a ventilator, or any other means of occaſioning a draught of air, might be uſed. The object required being only to produce a current of air, round the grinding-ſtone, that may be capable of carrying off the dangerous effluvia ariſing from the colours.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REPERTORY

OF

ARTS AND MANUFACTURES.

NUMBER XXVII.

XVIII. *Specification of the Patent granted to Mr.* William Nicholson, *of New North-ſtreet, Red-Lion Square; for a Machine or Inſtrument for printing on Paper, Linen, Cotton, Woollen, and other Articles, in a more neat, cheap, and accurate Manner, than is effected by the Machines now in Uſe.*

WITH THREE PLATES.

Dated April 29, 1790.

TO all to whom theſe preſents ſhall come, &c. Now know ye that, in compliance with the ſaid

proviſo, I the ſaid William Nicholſon do hereby declare, that my ſaid invention is deſcribed in the plan hereunto annexed, and the deſcription thereof hereunder written, and in manner following; that is to ſay, my invention conſiſts in three parts or particulars; namely, firſt, the manner or method of making, preparing, or placing, the original model, models, caſts, types, engravings, carvings, or ſculptures from which the impreſſion is to be made. Secondly, in applying the ink, or colouring-matter, to ſuch models, caſts, types, engravings, carvings, or ſculptures. And, thirdly, in taking off the impreſſion, or tranſferring the ink, or colouring-matter, from ſuch models, caſts, types, engravings, carvings, or ſculptures, to the paper, cloth, or other material upon which it is intended it ſhould remain.

I. In the firſt place then, I not only avail myſelf of all the methods of making, preparing, and placing, the original models, caſts, types, engravings, carvings, or ſculptures which have hitherto been known or uſed in printing, and do myſelf make uſe of them in conjunction with my newly-invented method of applying the ink, or

colouring-

colouring-matter, to ſuch original models, caſts, types, engravings, carvings, or ſculptures, and alſo with my newly-invented method of taking off the impreſſions, but I do likewiſe make, put together, and arrange them in a new manner, as occaſion may require; that is to ſay,

II. I make my moulds, punches, and matrices, for caſting letters, in the ſame manner, and with the ſame materials, as other letter-founders do, excepting that, inſtead of leaving a ſpace in the mould for the ſtem of one letter only, I leave ſpaces for two, three, or more letters, to be caſt at one pouring of the metal; and at the lower extremity of each of thoſe ſpaces (which communicate by a common groove at top) I place a matrix, or piece of copper with the letter punched upon its face in the uſual way. And moreover, I bring the ſtem of my letters to a due form and finiſh, not only by rubbing it upon a ſtone, and ſcraping it when arranged in the finiſhing-ſtick, but likewiſe by ſcraping it, on one or more ſides, in a finiſhing-ſtick whoſe hollowed part is leſs deep at the inner than the outer ſide. I call that ſide of the groove which is neareſt the face of the diſpoſed

letter, the outer ſide; and the purpoſe accompliſh-ed by this method of ſcraping is, that of render-ing the tail of the letter gradually ſmaller the more remote it is, or farther from the face. Such letter may be firmly impoſed upon a cylindrical ſurface, in the ſame manner as common letter is impoſed upon a flat ſtone. I ſpecify and affirm that the above deſcribed methods of caſting two or more letters at once, and of chamfering or ſloping their tails, are parts of my new inven-tion.

III. I impoſe or diſpoſe my letter for printing in the common manner, to be uſed in conjunction with my newly-invented improvements. And I likewiſe impoſe it in frames or chaſes adapted to the ſurface of a cylinder of wood, or metal, and faſten it to the ſaid ſurface by ſcrews, or wedges, or in grooves, or by other methods well known to workmen; and this impoſing letter upon a cy-linder I ſtate and affirm to be part of my new invention.

IV. I cut, carve, engrave, chaſe, caſt, model or make, (in the uſual manner of performing thoſe operations,) blocks, forms, plates, types, or ori-

ginals,

ginals, to be uſed for printing, either of wood, metal, or other materials; and theſe I uſe in conjunction with my other newly-invented improvements. I likewiſe, for other kinds of work, do faſten with glue, cement, ſcrews, wedges, or by other known methods, ſuch blocks, forms, plates, types, or originals, as aforeſaid, to the ſurface of a cylinder. I likewiſe, for other kinds of work, do cut, carve, engrave, chaſe, caſt, model or make, blocks, forms, plates, types, or originals, as aforeſaid, of a cylindrical form, of wood, metal, or other materials. And I ſtate and affirm that this diſpoſition of blocks, forms, plates, types, or originals, upon a cylinder, and alſo that the cutting, carving, engraving, chaſing and caſting, modelling or making, blocks, plates, types, or originals, of a cylindrical form, as aforeſaid, are parts of my new invention.

V. In the ſecond place, I diſtribute or apply the ink, or colouring-matter, upon the ſurface, or in the interſtices, of the blocks, forms, plates, types, or originals aforeſaid, by cauſing the ſurface of a cylinder, ſmeared or wetted with the colouring-matter, to roll over, or ſucceſſively

apply

apply itſelf to, the ſurfaces of the ſaid blocks, forms, plates, types, or originals, of whatever figure or conſtruction ſuch blocks, forms, plates, types, or originals, may be. Or elſe I cauſe the ſaid blocks, forms, plates, types, or originals, ſucceſſively to apply themſelves to the ſaid cylinder. I call the ſaid ſmeared or wetted cylinder, the colouring-cylinder. Its ſurface is covered with leather, or the dreſſed ſkins which printers call pelts, or elſe it is covered with woollen, or linen, or cotton cloth. When the colour to be uſed is thin, as in calico-printing, and in almoſt every caſe, the covering is ſupported by a firm elaſtic ſtuffing, conſiſting of hair, or wool, or woollen cloth wrapped one or more folds round the cylinder. When the covering conſiſts of woollen cloth, the ſtuffing muſt be defended by leather, or oilſkin, to prevent its imbibing too much colour, and by that means loſing its elaſticity. It is abſolutely neceſſary that the colouring-matter be evenly diſtributed over the ſurface of the cylinder; for this purpoſe, when the colour is thick and ſtiff, as in letter-preſs printing, I apply two, three, or more ſmall cylinders, called

called diſtributing-rollers, longitudinally againſt the colouring-cylinders, ſo that they may be turned by the motion of the latter; and the effect of this application is, that every lump or maſs of colour which may be redundant, or irregularly placed upon the face of the colouring-cylinder, will be preſſed, ſpread, and partly taken up, and carried by the ſmall rollers to the other parts of the colouring-cylinder; ſo that this laſt will very ſpeedily acquire and preſerve an even face of colour. But, if the colouring-matter be thinner, I do not apply more than one or two of theſe diſtributing-rollers; and, if it be very thin, I apply an even blunt edge of metal, or wood, or other material, or a ſtraight bruſh, or both of theſe laſt, againſt the colouring-cylinder, for the purpoſe of rendering its colour uniform.

VI. When I apply colour to an engraved plate or cylinder, or apply the colour through the interſtices of a perforated pattern, or cylinder, as in the manufacturing of ſome kinds of paper-hangings and floor-cloths, I uſe a cylinder entirely covered with hair or briſtles, in the manner of a bruſh.

VII. The

VII. The whole of the manipulations or practices described in the two preceding paragraphs (numbers V. and VI.) are parts of my new invention.

VIII. In the third place, I perform all my impressions by the action of a cylinder, or cylindrical surface; that is to say, I cause the paper, or cloath, or other material intended to be printed upon, (and previously damped if necessary,) to pass between two cylinders, or segments of cylinders, in equal motion; one of which has the block, form, plate, assemblage of types, or originals, attached to, or forming part of, its surface, and the other is faced with cloth or leather, and serves to press the paper, cloth, or other material, as aforesaid, so as to take off an impression of the colour previously applied. Or otherwise, I cause the block, form, plate, assemblage of types, or originals, previously coloured, to pass in close and successive pressure or contact with the paper, or cloth, or other material, wrapped round a cylinder with woollen. Or otherwise, I cause the last-mentioned cylinder, with the paper, or cloth, or other material wrapped round it, to roll along the face of the block, form, plate,

aſſemblage of types, or originals, previouſly coloured. Or otherwiſe, I cauſe a cylinder having the block, form, plate, aſſemblage of types, or originals, attached to, or forming part of, its ſurface, to roll along the ſurface of the paper, cloth, or other material intended to be printed, and previouſly ſpread out upon an even plane covered with cloth or leather; the ſaid cylinder being ſupplied with colour by means of a colouring cylinder herein before deſcribed, and herein after more particularly to be noticed.

IX. The foregoing deſcription ſhews the nature of my invention; which may be applied to a great variety of uſes, and conſtructed or put together in a great variety of forms. Its uſes conſiſt in the printing of books in general, the printing of paper-hangings, floor-cloths, cottons, linens, woollens, ſilks, ribands, laces, leather, ſkin, and every other flexible material whatever. And its form or conſtruction, being no eſſential part of the invention, may without difficulty be obtained and carried into effect, by any workman poſſeſſed of common ſkill and ability. Nevertheleſs, as there may be ſome artiſts of ſuch a mode-

rate capacity as to find the foregoing inſtructions not ſufficient to enable them to conſtruct my machines, I ſhall proceed to exhibit drawings, and deſcribe ſeveral methods of conſtructing them. But, at the ſame time, I think it pertinent to take notice, that as the following conſtructions cannot be excluſively claimed by me by virtue of his Majeſty's letters patent granted unto me, excepting ſo far as the ſame include or contain my new improvements and inventions, ſo, on the other hand, I do not exhibit the ſame as the only practicable methods of carrying my invention into effect, but I claim the general and univerſal application of the principles diſcovered and brought into practice by me, as before deſcribed; and do here proceed to exhibit and deſcribe certain ſpecific applications of thoſe principles, chiefly from a conviction that it is my duty to render this preſent ſpecification clear and intelligible by every means in my power. And moreover, ſince in the following applications or particular methods there are, and may be found, ſeveral contrivances reſulting from a conſiderable ſhare of deliberation, labour, and expence, and tending to facilitate the practice

practice of my ſaid inventions, I do not by any means hereby exclude the following deſcriptions and drawings from my preſent ſpecification; for I do not conſider them as being merely illuſtrative of the general principles herein before deſcribed and explained, but do hereby aſſert and maintain, that all and every parts and part of the machines herein after deſcribed, which have not hitherto been uſed as parts of ſome other machine, or in combination directed to the accompliſhment of the like purpoſe of printing, are ſtated and claimed by me as parts of my ſaid invention; for the excluſive enjoyment of which, as well as of every other part of the ſaid invention hereby ſpecified by me, I claim all protection and every advantage which, by his Majeſty's letters patent, I may lawfully be entitled to.

Explanation of the annexed Drawings.

(See Plates VIII, IX, and X.)

Fig. 1 (Plate VIII.) repreſents a printing-preſs, more eſpecially applicable to the printing of ſheets of paper, or books. A and E repreſent two cylin-

 ders,

ders, running or turning in a ſtrong frame of wood, or metal, or both. The cylinder A is faced with woollen cloth, and is capable of being preſſed with more or leſs force upon H I, by means of the lever M. H I is a long table, which is capable of moving endways, backwards and forwards, upon the rollers E and K. The roller A acts upon this table by means of a cog-wheel, or by ſtraps, ſo as to draw it backwards and forwards by the motion of its handle L. The table is kept in the ſame line by grooves on its ſides, which contain the cylinder A. D is a chaſe, containing letter ſet up and impoſed. B is a box, containing a colouring-roller, with its diſtributing-rollers C C; it is ſupported by the arm N. O is a cylinder faced with leather, and lying acroſs an ink-block; this cylinder is fixed by the middle to a bended lever movable on the joint Q.

The action. When D, or the letter, is drawn beneath the cylinder B, it receives ink; and when it has paſſed into the poſition R, a workman places or turns down a tympan with paper upon it; (this tympan differs in no reſpect from the uſual one, except that its hinge opens ſideways;) it then proceeds

proceeds to paſs under the cylinder A, which preſſes it ſucceſſively through its whole ſurface. On the other ſide, at S, the workman takes off the paper, and leaves the tympan up. This motion cauſes the cylinder B to revolve continually, and conſequently renders its inked ſurface very uniform, by the action of its diſtributing-rollers C C; and, when the table has paſſed to its extreme diſtance in the direction now ſpoken of, the arm G touches the lever P, and raiſes the cylinder O off the ink-block, by which means it dabs againſt one of the diſtributing-rollers, and gives it a ſmall quantity of ink. The returning motion of the table carries the letter again under the roller B, which again inks it, and the proceſs of printing another ſheet goes on as before. N. B. The table in this drawing is not quite long enough in its dimenſions, compared with the inking-roller.

Fig. 2 is another printing-preſs; in this, B is the inking-roller; A is a cylinder, having the letter impoſed upon its ſurface; and E is a cylinder, having its uniform ſurface covered with woollen cloth; theſe three cylinders are connected, either by cogs or ſtraps at the edges

of

of each. The machine is uniformly turned in one direction by the handle L. The workman applies a ſheet of paper to the ſurface of E, where it is retained, either by points in the uſual manner, or by the apparatus to be deſcribed in treating of Fig. 4. The paper paſſes between E and A, and receives an impreſſion; after which the workman takes it off, and applies another ſheet; and in the mean time the letter on the ſurface of A paſſes round againſt the ſurface of B, and receives ink during the rotation of B. The diſtributing-rollers C C do their office as in the machine Fig 1; and once in every revolution the tail F, affixed to B, raiſes the inking-piece G, ſo as to cauſe it to touch one of the diſtributing-rollers, and ſupply it with ink. In this way therefore the repeated printing of ſheet after ſheet goes on.

Fig. 3 is a printing-preſs, more particularly adapted to print cottons, ſilks, paper-hangings, or other articles which run of a conſiderable length. A is a cylinder covered with woollen cloth, or other ſoft ſubſtance. The web or piece of cotton, or other goods, is paſſed round this cylinder, from the carrying-roller F to the receiving-

ving-rollers G H; which are connected by a piece of linen, woollen, or hair-cloth, in the manner of a jack-towel sewed round them; the rotation of this towel carries away the printed stuff or goods, and deposits them at I. K L is a movable box, containing three rollers, which move against each other in rotation. The lowest roller C revolves in a mass of colour, contained in a trough or vessel in the bottom part of the box K L; the surface of this colour is represented by the line M N. The next roller B is stuffed and covered, as described in paragraph V. The pressure of B against C prevents the cylinder B from receiving too much colour. D is the carved or cut cylinder mentioned in paragraph IV. or any other of the cylindrical contrivances there mentioned; it receives colour, during the rotation, from the roller B, and impresses it upon the web as it passes round the cylinder A; in this way the constant and effectual action of the machine is sufficiently obvious. It must be observed, that the cylinders A D B and G are connected together by cog-wheels, straps, or other well-known equivalent contrivances; so that the handle P drives

drives the whole, without their neceſſarily depending on any adheſion or friction at their ſurfaces. The preſſure of B againſt D is governed by an adjuſtment of the axis of D, whoſe ſockets are capable of a ſmall motion; and the preſſure of D againſt A is governed by the poſition of the whole box K L. There are many other well-known ways of thus communicating the motions, and of regulating the preſſures; but as they are in general uſe in mills, and other rotary machines of various kinds, I do not conſider it to be neceſſary, in this place, to ſay more than that I alſo uſe them in the conſtruction of my new machines. When it is required to print more than one colour upon a piece, I cauſe it to paſs two or more times through the machine; or, in thoſe caſes where the materials are liable to change their dimenſions, I apply, at one and the ſame time, two or more ſuch boxes as K L, with their reſpective cylinders, ſo that the pattern-cylinder of each may make its impreſſion upon the web or material to be printed on. In this operation I am particularly careful to adjuſt the reſpective pattern-cylinders to each other, by trials on a waſte

piece

piece of the material, before I proceed to operate upon goods for ſale; and in this way a variety of colours are impreſſed at one and the ſame time.

Fig. 4 (Pl. IX.) is a printing-preſs, chiefly of uſe for books and papers. 1 2 3 4 repreſents a long table, with ledges on each ſide; ſo that the two cylinders A and B can run backwards and forwards without any ſide ſhake. In one of theſe ledges is placed a ſtrip or plate of metal cut into teeth, which lock into correſpondent teeth in each cylinder; by which means the two cylinders roll along, without the poſſibility of changing the relative poſitions of their ſurfaces at any determinate part of the table. This may alſo be effected by ſtraps, and may indeed be accompliſhed, with tolerable accuracy, by the mere rolling of the cylinders on the ſmooth or flat edges without any proviſion. A is the printing cylinder, covered with woollen cloth, and B is the inking-cylinder, with its diſtributing-rollers. The table may be divided into four compartments, marked with a thicker bounding-line than the reſt, and numbered 1 2 3 4. At 1 is placed a ſheet of paper;

 at

at 2 is the form or chafe, containing letter fet and impofed; at 3 is an apparatus for receiving the printed fheet; and 4 is employed in no other ufe than as a place of ftanding for the carriage E, after it has paffed through one operation, and when it takes ink at F. Its action is as follows: the carriage is thruft forward by the workman, and as the roller A paffes over the fpace numbered 1, it takes up the fheet of paper previoufly laid there, while the roller B runs over the form and inks the letter. The fheet of paper, being wrapped round the cylinder A, is preffed againft the form as that cylinder proceeds, and confequently it receives an impreffion. When A arrives at the fpace numbered 3, it lets go the fheet of paper, while the prominent part of the carriage, G, ftrikes the lever P, and raifes the inking-piece, which applies itfelf againft one of the diftributing-rollers. In this manner therefore the cylinder A returns empty, and the cylinder B inked, and in the mean time the workman places another fheet of paper ready in the fpace numbered 1. Thus it is that the operation proceeds in the printing of one fheet after another.

The

The preceding defcription is not incumbered with an account of the apparatus by which the paper is taken up and laid down. This may be done in feveral ways: Figs. 9 and 10 reprefent one of the methods. DE is a lever, moving on the centre pin C, and having its end D preffed upwards by the action of the fpring G. The fhoulder which contains the pin C is fixed in another piece F, which is inferted in a groove in the furface of the cylinder A; (Fig. 4;) fo that it is capable of moving in and out, in a direction parallel to the axis of that cylinder. As that cylinder proceeds, it meets a pin in the table; which, (letter P, Fig. 9,) acting on the inclined plane at the other end of the lever, throws the whole inwards, in the pofition reprefented in Fig. 10; in which cafe the extremity D fhoots inwards, and applies itfelf againft the fide of the cylinder.

In Fig. 11 is a reprefentation of part of the table; the dotted fquare reprefents a fheet of paper, and the four fmall fhaded fquares denote holes in the board, with pins ftanding befide them. When the lever DE (Fig. 10) fhoots forward, it is fitu-

ated in one of theſe holes, and advances under the edge of the paper, which conſequently it preſſes and retains againſt the cylinder with its extremity D. Nothing more remains to be ſaid reſpecting the taking up, but that the cylinder is provided with two pair of theſe claſps or levers, which are ſo fixed as to correſpond with the four holes repreſented in Fig. 11. It will be eaſy to underſtand how the paper is depoſited in the compartment N°. 3. (Fig. 4.) A pin P, (Fig. 10,) riſing out of the platform or table, acts againſt a pin E, projecting ſideways out of the lever, and muſt of courſe draw the ſlider and its lever to the original poſition; the paper conſequently will be let go, and its diſengagement is rendered certain by an apparatus fixed in the compartment numbered 3, (Fig. 4,) of exactly the ſame kind as that upon the cylinder, and which, by the action of a pin duly placed in the ſurface of the cylinder A, takes the paper from the cylinder in preciſely the ſame manner as that cylinder originally took it up in the compartment numbered 1. (Fig. 4.)

Figs.

Figs. 5, 6, and 7, (Pl. X.) represent a simpler apparatus for accomplishing the same purpose. If A *a* B *b* (Fig. 7) be supposed to represent a thick plate of metal of a circular form, with two pins A and B proceeding sideways or perpendicularly out of its plane, and diametrically opposite to each other, and G another pin proceeding in the direction of that plane, then it is obvious that any force applied to the pin A, so as to press it into the position *a*, (by turning the plate on its axis or centre X,) will at the same time cause the pin G to acquire the position *g*; and, on the other hand, when B is at *b*, or the dotted representation of the side-pin, if any pressure be applied to restore its original position at B, the pin *g* will return back to G. Now the figures 5 and 6 exhibit an apparatus of this kind, applied to the cylinder A; and that cylinder, by rolling over the pins P and *p*, properly fixed in the table to re-act upon the apparatus, will cause its prominent part G, either to apply to the cylinder and clasp the paper, or to rise up and let it go. The compartment numbered 3 (Fig. 4) must of course have an apparatus of the same kind, to be acted upon

upon by pins from A, in order that it may take the paper from that cylinder.

There is one other circumſtance belonging to this machine which remains to be explained. When the carriage E (Fig. 4) goes out in the direction of the numbers 1 2 3 4, both rollers, A and B, preſs the form of letter in their paſſage; but in their return back again the roller A, having no paper upon it, would itſelf become ſoiled, by taking a faint impreſſion from the letter, if it were not prevented from touching it: the manner of effecting this may be underſtood from Fig. 12. The apparatus there repreſented is fixed upon the outſide of the carriage E, near the lower corner, in the vicinity of the roller A; the whole of this projects ſideways beyond the ledge of the table, except the ſmall truck or wheel B. The irregularly-triangular piece, which is ſhaded by the ſtroke of the pen, carries this wheel, and alſo a catch movable on the axis or pin E. The whole piece is movable on the pin A, which connects it to the carriage. C D, or the part which is ſhaded by dotting, is a detent which ſerves to hold the piece down in a certain poſition. It may be

be obſerved, that both the detent and the triangular piece are furniſhed each with a claw, which holds in one direction, but trips or yields in the other, like the jacks of a harpſicord, or reſembling certain pieces uſed in clock and watch making, as is clearly repreſented in the drawing. Theſe claws over-hang the ſide of the table, and their effect is as follows. There is a pin C (Fig. 4) between the compartments of the table numbered 2 and 3, but which is marked F in Fig. 12, where G H repreſents the table. In the outward run of the carriage theſe claws ſtrike that pin, but with no other effect than that they yield for an inſtant, and as inſtantly reſume their original poſition by the action of their reſpective ſlender back-ſprings. When the carriage returns, the claw of the detent indeed ſtrikes the pin, but with as little effect as before, becauſe its derangement is inſtantly removed by the action of the back-ſpring of the detent itſelf; but, when the claw of the triangular piece takes the pin, the whole piece is made to revolve on its axis or pin A, the wheel B is forced down, ſo as to lift that end of the carriage, and the detent, catching

on

on the piece at C, prevents the former poſition from being recovered. The conſequence of this is, that the carriage runs upon the truck B, (and its correſpondent truck on the oppoſite ſide,) inſtead of the cylinder A, which is too much raiſed to take the letter, and ſoil itſelf; but, as ſoon as the end of the carriage has paſſed clear of the letter, another pin R (Fig. 4) takes the claw of the detent, and draws it off the triangular piece; at which inſtant the cylinder A ſubſides to its uſual place, and performs its functions as before. This laſt pin R does not affect the claw of the triangular piece, becauſe it is placed too low; and the claw of the detent is made the longeſt, on purpoſe that it may ſtrike this pin.

Fig. 8 repreſents an inſtrument for printing floor-cloths, paper-hangings, and the like, with ſtiff paint and a bruſh. D is a copper or metallic cylinder fixed in a frame A, like a garden-roller; its carved part is thin, and is cut through in various places, according to the deſired pattern. A ſtrong axis paſſes through the cylinder, and its extremities are firmly attached to the frame A. To this axis is fixed a veſſel or box of the ſame kind,

kind, and anſwering the ſame purpoſe, as the box K L in Fig. 3. It carries a cylinder P, which revolves in the colour; another cylinder E, which revolves in contact with P; and a third cylinder B, whoſe exterior ſurface is covered with hair, after the manner of a bruſh, and revolves in contact with E. This cylinder B is adjuſted by its axis, in ſuch a manner that its bruſh-part ſweeps in the perforated parts of the metallic cylinder D. The circle C repreſents a cog-wheel, fixed concentric to the cylinder D, and revolving with it; this wheel takes another wheel concentric to, and fixed to, B: hence the action is as follows. When the metallic cylinder is wheeled or rolled along any ſurface, its cog-wheel C drives the bruſh B in the contrary direction; and this bruſh-cylinder, being connected by cogs or otherwiſe with E and P, cauſes thoſe alſo to revolve and ſupply it with colour. As the ſucceſſive openings of the cylinder D, therefore, come in contact with the ground, the ſeveral parts of the bruſh will traverſe the uncovered part of that ground, and paint the pattern upon it. The wheel G, being kept lightly on the ground, ſerves to determine

 the

the line of contact, that it ſhall be the part oppoſite to B, and no other.

Laſtly, I muſt take notice, that in theſe and every other of my machines, as well as in every machine whatever, the power may be wind, water, ſteam, animal ſtrength, or any other natural change capable of producing motion; and that the mechaniſm by which ſuch powers may be applied to produce a regular unceaſing, or an intermittent, motion, as circumſtances may require, may be uſed with theſe machines, though I have held it totally unneceſſary either to ſpecify or annex thoſe methods. The materials, the adjuſtments, the fittings, and that degree of accuracy neceſſary to the perfection of every machine, have likewiſe made no part of my ſpecification, becauſe every workman muſt know that no mechaniſm can be completed without a due attention to theſe well-known particulars. In witneſs whereof, &c.

XIX.

Fig. 1.

Fig. 2.

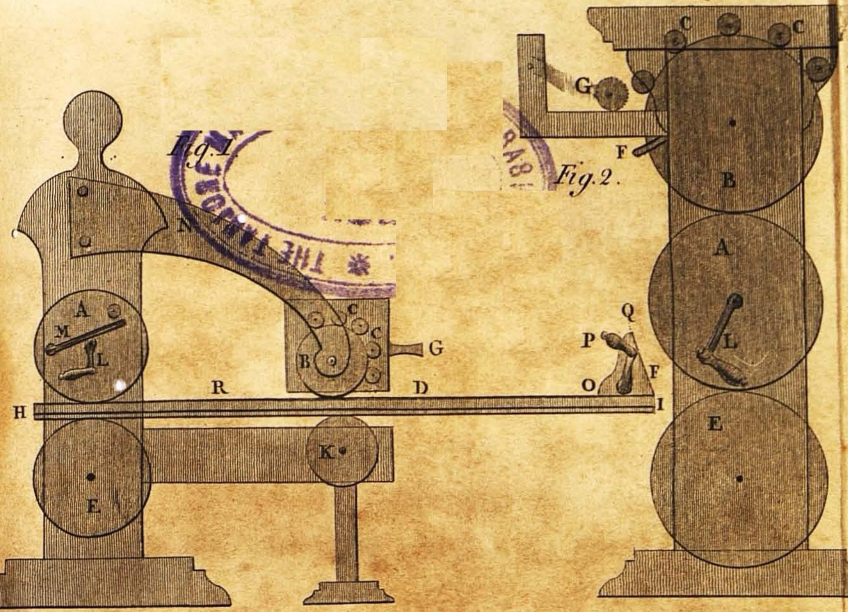
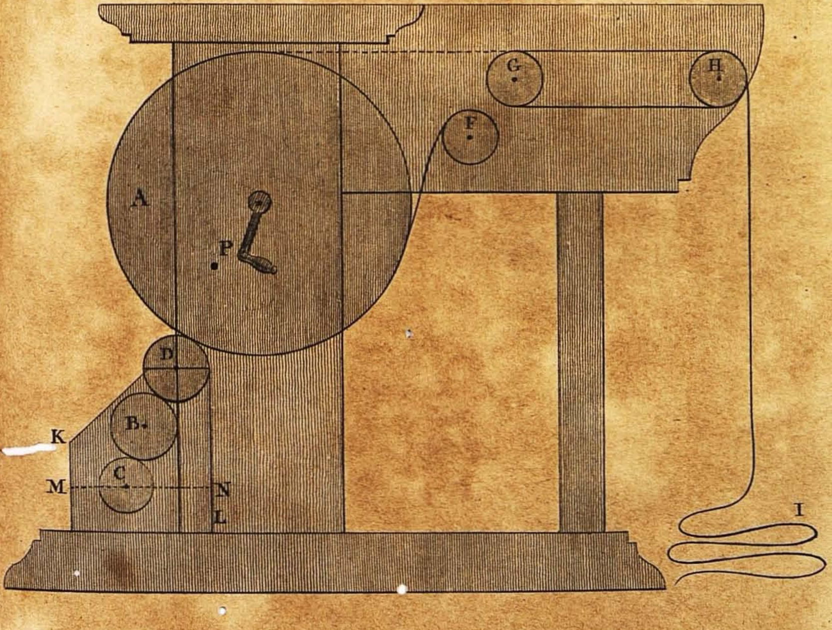


Fig. 3.



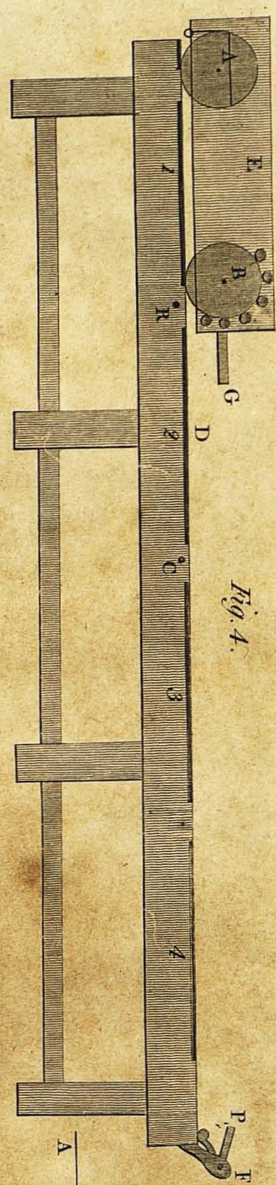


Fig. 4.

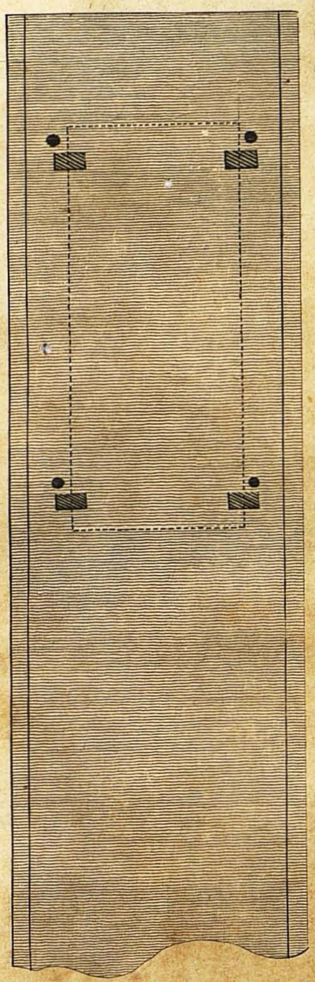


Fig. 11.

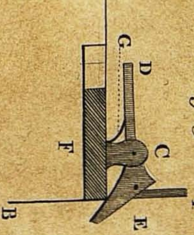


Fig. 9.

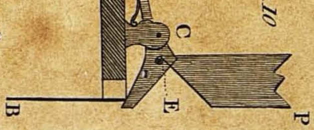


Fig. 10

XIX. *Specification of the Patent granted to Mr.* Richard Tillyer Blunt; *for his new-invented Composition to be used instead of Yeast.*

Dated October, 30, 1787.

To all to whom these presents shall come, &c. Now know ye that, in compliance with the said proviso, I the said Richard Tillyer Blunt do hereby declare, that my said new invention is composed and made in manner following; that is to say, to make a yeast-gallon of the above composition to be used as yeast, such yeast-gallon containing, and to contain, eight beer-quarts, boil in common water eight pounds of potatoes, as for eating; bruise them perfectly smooth, and mix with them, whilst warm, two ounces of honey, or any other sweet, and one quart (being the eighth part of a gallon of yeast) of common

 yeast.

yeaſt. And, for making bread, mix three beer-pints of the above compoſition with a buſhel of flour, uſing warm water in making the bread; the water to be warmer in winter than in ſummer; and the compoſition to be uſed in a few hours after it is made; and as ſoon as the ſponge (the mixture of the compoſition with the flour) begins to fall the firſt time, the bread ſhould be made and put in the oven. In witneſs whereof, &c.

XX. *Specification of the Patent granted to Mr.* JOHN GRIMSHAW, *of Strines-Hall, in the County of Derby, Calico-Printer; for his Invention or Diſcovery of certain vegetable Subſtances, in particular States of Preparation, to be uſed in clearing or bleaching printed, painted, ſtained, or dyed Cloths, &c.*

Dated Feb. 17, 1796.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE that, in purſuance of, and complance with, the ſaid recited proviſo, I the ſaid John Grimſhaw do hereby declare, that the nature of my ſaid invention or diſcovery is as follows. The vegetable ſubſtances, in particular ſtates of preparation, to be uſed in clearing or bleaching, or aſſiſting to clear or bleach, printed, painted, ſtained, or dyed cloths, or other materials, conſiſting of, or manufactured from, linen, cotton, hemp, ſilk, or wool, or any two or more of them, and other printed, painted, ſtained, or dyed goods,

goods, manufactured or produced from animal or vegetable materials, or both, conſiſt of the grains either of barley, wheat, oats, rye, or other corn, which remain after ſuch barley, wheat, oats, rye, or other corn, has been made into malt, or brought into a ſweet ſtate; and either brewed, for the purpoſe of making ale, beer, or other malt liquor, or uſed for the purpoſe of diſtillation. Such grains, in all caſes, to be brought into a ſour ſtate, either by keeping the ſame without mixture until they become ſour, or by mixing the ſame, either with ſour beer, or with alegar, or vinegar, or with cream of tartar, or with any other acid, in order to render the ſame ſour.

Manner of uſing the ſour grains. The manner of uſing ſuch ſour grains is, by putting three or four buſhels, or a greater or leſs quantity, of the ſame, either into a copper or other pan or veſſel, containing either two hundred gallons, or more or leſs, of water or other liquid, and either in a boiling or hot ſtate, and putting four, or more or fewer, pieces of ſuch printed, painted, ſtained, or dyed cloths, or other materials or goods, into ſuch mixture, and continuing the ſame in ſuch mix-

ture

ture either for five or ten minutes, or a greater or less length of time. This operation may be performed in a copper pan, exactly similar to those which are used by calico-printers, for the purpose of clearing their printed calicoes, cottons, and linens, with bran; and it renders the use of bran unnecessary. The operation may be greatly expedited by working the pieces quickly out of and into the mixture, by means of a winch or reel, placed across the top of the pan or vessel above the mixture, over which winch or reel each of the pieces may be made to pass. The winch or reel may be turned quickly round, either by the hand of a man, or any other power. The manner in which I generally exercise my invention or discovery is as follows; I take any quantity of common brewhouse-grains, such as remain after ale or beer has been brewed in the common way from barley-malt, and put them close together into a vessel, tub, cask, or cistern, for the purpose of turning them sour. In hot weather they will become sour in about six days; in cold weather they will become sour in about eight days. When the grains are sour, I put two, three, or four

Winchester

Wincheſter buſhels of them into a common-ſized calico-printer's dying copper pan, nearly full of boiling water. Into this mixture I put four pieces, containing about twenty-one or twenty-eight yards each in length, of printed calicoes, cottons, or linens, and work them quickly out of and into the mixture, by turning them over a winch or reel, as before deſcribed, placed over and acroſs the pan. I continue this operation from five to ten minutes, during which time I let the mixture gently boil. I then take out the pieces and waſh them immediately, either in hot water or cold water, and afterwards treat them in the ſame manner as is uſually done with printed goods by calico-printers, when ſuch printed goods have been cleared with bran. After I have uſed this mixture for clearing twelve or ſixteen pieces, I put one additional buſhel of ſuch four grains as laſt mentioned into the pan, and fill the pan up with additional water; when it boils, I repeat the operation with other printed calicoes, cottons, and linens, as before. In witneſs whereof, &c.

XXI.

XXI. *Specification of the Patent granted to Mr.* JOHN WORTH, *of Diſs, in the County of Norfolk, Chemiſt; for a Preparation or Cement for the Purpoſe of preſerving his Majeſty's and other Ships and Veſſels from Worms, &c. and for various Purpoſes in Agriculture and Commerce.*

Dated May 28, 1771.—Term expired.

TO all to whom theſe preſents ſhall come, &c. Now KNOW YE that, in compliance with the ſaid proviſo, I the ſaid John Worth do hereby declare, that my ſaid invention of a preparation or cement for the purpoſe of preſerving his Majeſty's and other ſhips and veſſels from worms, &c. by the paying of their ſides and bottoms, and for various purpoſes in agriculture and commerce, for preſerving buildings, &c. made of wood, from the weather, is to be performed in the following manner; that is to ſay, take of powdered or ſmall pieces of roſin fourteen pounds, ſand ſifted and

waſhed clean from dirt, or loam, twenty-eight pounds, red-lead three pounds and a half, oil one pound and three-fourths; melt the roſin over a moderate fire, put the ſand and lead in by degrees, then put in your oil; when they are boiling keep them conſtantly ſtirring till cold, that you may have an uniform maſs. Take of this maſs or cement ſuch quantity as may ſuit your purpoſe, broke into ſmall pieces, and to every twelve pounds put in a bare half pound of oil. When melted, apply it to what you deſign, either by pouring it on, or uſing it with a bruſh, while boiling hot. It is to be obſerved that your oil, to be added to the cement, muſt be of that ſort which chemiſts call fat oil; and that more or leſs muſt be uſed as you want the compoſition to be harder or ſofter. This will be of a reddiſh colour; for the white, and green, I uſe ceruſs, and verdegris, in the ſame proportion as the minium or red-lead. In witneſs whereof, &c.

XXII. *Description of a Machine for cutting Files.* *By* B. O.

WITH A PLATE.

From the TRANSACTIONS of the AMERICAN PHILOSOPHICAL SOCIETY.

AAAA, (Plate XI,) a bench, made of well-feasoned oak, and the face of it planed very fmooth.

BBBBB, the feet of the bench, which fhould be fubftantial.

CCCC, the carriage on which the files are laid, which moves along the face of the bench AAAA, parallel to its fides, and carries the files gradually under the edge of the cutter or chifel HH, while the teeth are cut: this carriage is made to move by a contrivance fomewhat fimilar to that which carries the log againft the

 faw

ſaw of a ſaw-mill, as will be more particularly deſcribed.

D D D are three iron rods, inſerted into the ends of the carriage C C C C, and paſſing through holes in the ſtuds E E E, which are ſcrewed firmly againſt the ends of the bench A A A A, for directing the courſe of the carriage C C C C parallel to the ſides of the ſaid bench.

F F, two upright pillars, mortiſed firmly into the bench A A A A, nearly equidiſtant from each end thereof, near the edge, and directly oppoſite to each other.

G, the lever or arm, which carries the cutter H H, (fixed by the ſcrew I,) and works on the centres of two ſcrews K K, which are fixed into the two pillars F F, in a direction right acroſs the bench A A A A. By tightening or looſening theſe ſcrews, the arm which carries the chiſel may be made to work more or leſs ſteady.

L is the regulating-ſcrew, by means of which the files may be made coarſer or finer; this ſcrew works in a ſtud M, which is ſcrewed firmly upon the top of the pillar F. The lower end of the ſcrew

ſcrew L bears againſt the upper part of the arm G, and limits the height to which it can riſe.

N, a ſteel ſpring, one end of which is ſcrewed to the other pillar F, and the other end preſſes againſt the pillar O, which is fixed upon the arm G; by its preſſure, it forces the ſaid arm upwards, until it meets with the regulating-ſcrew L.

P is an arm with a claw at one end, marked 6, the other end is fixed by a joint into the end of the ſtud or pillar O; and, by the motion of the arm G, is made to move the ratch-wheel Q. This ratch-wheel is fixed upon an axis, which carries a ſmall trundle-head or pinion R, on the oppoſite end; this takes into a piece S S, which is indented with teeth, and ſcrewed firmly againſt one ſide of the carriage C C C C; by means of this piece the carriage has motion communicated to it.

T is a clamp, for faſtening one end of the file Z Z in the place or bed on which it is to be cut.

V is another clamp or dog, at the oppoſite end, which works by a joint W, firmly fixed into the carriage C C C C.

Y, a bridge, likewiſe ſcrewed into the carriage, through which the ſcrew X paſſes, and preſſes with its lower end againſt the upper ſide of the clamp V; under which clamp the other end of the file Z Z is placed, and held firmly in its place while it is cutting, by the preſſure of the ſaid clamp or dog V.

7 7 7 7 is a bed of lead, which is let into a cavity formed in the body of the carriage, ſomething broader and longer than the largeſt-ſized files; the upper face of this bed of lead is formed variouſly, ſo as to fit the different kinds of files which may be required.

2 2, two catches, which take into the teeth of the ratch-wheel Q, to prevent a recoil of its motion.

3 3 is a bridge to ſupport one end of the axis 4, of the ratch-wheel Q.

5, a ſtud to ſupport the other end of the axis of the ratch-wheel Q.

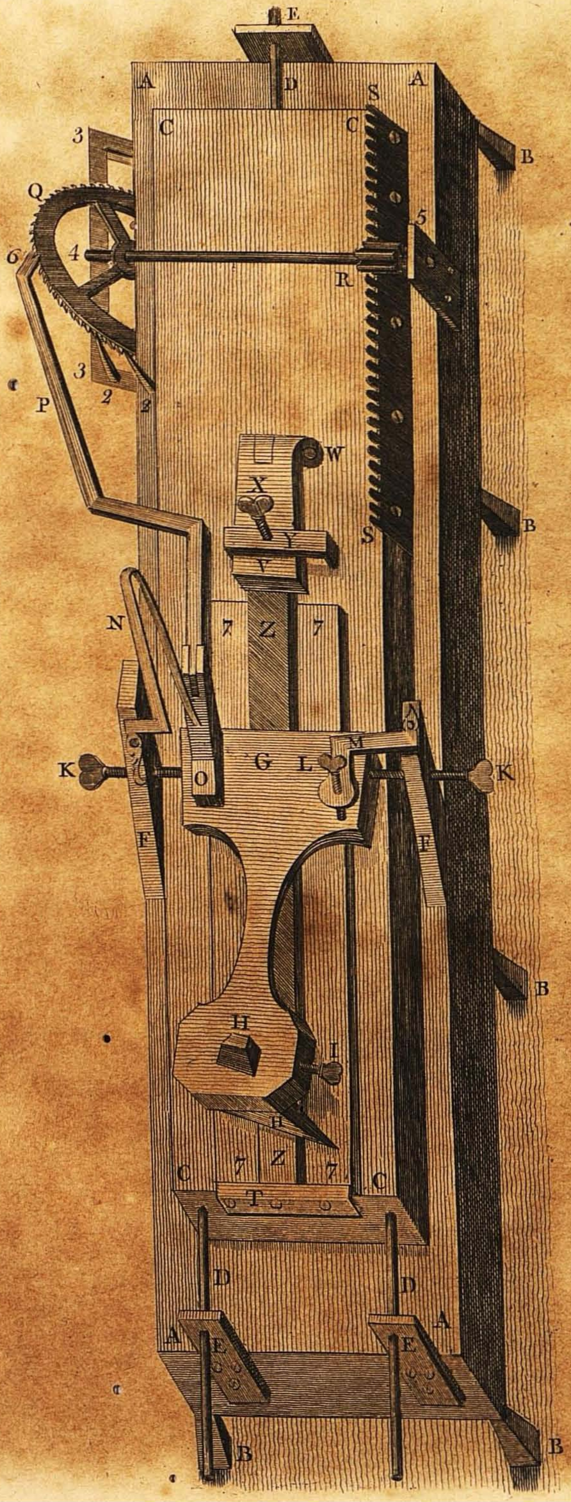
When the file or files are laid in their place, the machine muſt be regulated to cut them of the due degree of fineneſs by means of the regulating-

gulating-ſcrew L; which, by ſcrewing farther through the arm M, will make the files finer, and, *vice verſa*, by unſcrewing it a little, will make them coarſer; for, the arm G will, by that means, have liberty to riſe the higher, which will occaſion the arm P, with the claw, to move farther along the periphery of the ratch-wheel, and conſequently communicate a more extenſive motion to the carriage C C C C, and make the files coarſer.

When the machine is thus adjuſted, a blind man may cut a file with more exactneſs than can be done in the uſual method with the keeneſt ſight; for, by ſtriking with a hammer on the head of the cutter or chiſel H H, all the movements are ſet at work; and, by repeating the ſtroke with the hammer, the files on one ſide will at length be cut; then they muſt be turned, and the operation repeated, for cutting the other ſide. It is needleſs to enlarge much on the utility or extent of this machine; for, on an examination, it will appear to perſons of but indifferent mechanical ſkill, that it may be made to work by

water

water as readily as by hand, to cut coarſe or fine, large or ſmall, files, or any number at a time; but it may be more particularly uſeful for cutting very fine ſmall files for watchmakers, as they may be executed by this machine with the greateſt equality and nicety imaginable. As to the materials and dimenſions of the ſeveral parts of this machine, I ſhall leave that to the judgement and ſkill of the artiſt who may have occaſion to make one, only obſerving that the whole ſhould be capable of bearing a good deal of violence.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XXIII. *On the Converſion of animal Subſtances into a fatty Matter much reſembling Spermaceti. By* GEORGE SMITH GIBBES, *B. A.*

From the TRANSACTIONS of the ROYAL SOCIETY of LONDON.

IN a paper which the Royal Society have done me the honour of inſerting in the laſt volume of their tranſactions, I related ſome experiments on the decompoſition of animal muſcle *. I regret that it has not been in my power to purſue theſe inquiries with the attention the ſubject ſeems to demand. I beg leave, however, to preſent the few additional facts contained in this paper, not by any means as a full inveſtigation of the ſubject, but as ſerving to excite the attention of thoſe who

* For theſe experiments ſee our ſecond volume, page 105.

have more opportunities, and are better qualified, to pursue such inquiries.

I mentioned, in my former paper, that the substance procured, either by means of water, or the nitrous acid, appeared to me to have precisely the same external characters; but, I have observed since, that there is a difference between that which I obtain from quadrupeds, and that which is procured from the human subject: the former seems not disposed to crystalize, while the latter assumes a very beautiful and regular crystaline appearance.

The matter which I procured from human muscle was melted, into which I plunged a very sensible thermometer, which soon rose to 160°; it began congealing at 112°, and became so solid at 110°, that the thermometer could not easily be taken out.

I took some of the spermaceti of the shops, and under the same circumstances I plunged the same thermometer into it. It soon rose to 170°; a pellicle was formed at the top of it when at 117°; and it became so solid at 114°, that the thermometer could not easily be taken out.

I dis-

I diſſolved a piece of the ſubſtance, which I had formed by means of water and the nitrous acid, in boiling ſpirit of wine; on cooling this mixture, a great quantity of this waxy matter was ſeparated in the form of beautiful flakes. I could not procure large cryſtals, but the flakes aſſumed a cryſtaline appearance.

I put into an earthen retort ſome of this waxy matter, to which I added ſome finely-powdered charcoal; on applying a pretty ſtrong fire, a ſmall quantity of an oily fluid came over, which concreted on cooling; after which came over a prodigious quantity of thick white vapours, which were very ſuffocating and offenſive.

I had a copper retort made, for the purpoſe of trying ſome experiments on this matter. I put a ſmall quantity into it, and placed it on a common fire; there came over firſt a limpid fluid like water, without much ſmell; on the addition of more heat, there came over an oily fluid, which ſoon coagulated of a firmer conſiſtence than when put in, and was coloured of a beautiful green by the copper; this laſt circumſtance proves that it contained no ammonia.

Having procured some very pure quickfilver, I took a glafs, which contained about ten pounds of that fluid, with which I filled it; I inverted it in a bafon, which contained the fame fluid; I introduced a fmall piece of lean meat, and alfo a fmall quantity of water. At the end of about fix weeks, fo great a quantity of gas was difengaged as nearly to occupy the whole of the veffel; the meat had affumed a white appearance.

Since I mentioned my former experiments on the cow which I had fubmitted to the action of running water, I have obferved a few facts relating to the changes which took place. This cow was placed in a fituation where the water could come twice every day, as before defcribed; over it fome loofe earth was thrown. After it had remained fome time in this place, I ufed frequently to pufh a ftick through this earth to the cow; every time this was done there came up a prodigious quantity of air, after I had fuffered it to remain quiet for a fhort time. Since I put the cow in this fituation, I have had two horfes and another cow placed under the fame circumftances; in all

all of them this diſengagement of air takes place; this air is extremely offenſive.

In the former cow the whole muſcular part ſeemed changed; and from the ſubſtance formed I have procured a very large quantity of a waxy ſubſtance, by means of the nitrous acid. Though the nitrous acid takes off the greateſt part of the fœtor from the ſubſtance thus formed, yet it gives it a yellow colour, which is with difficulty removed, and a peculiar ſmell, evidently ſimilar to the ſmell of the acid employed, which mere waſhing, and the addition of alkalies, will not intirely remove.

My father, who has been indefatigable in his attempts to whiten this ſubſtance, finds that the following proceſs will make it very pure, and very beautiful, though not ſo white as the ſpermaceti of the ſhops. The cow which had lain in the water for a year and an half was taken up, and we found that the whole muſcular part was perfectly changed into a white matter; this was broken into ſmall pieces, and was expoſed to the action of the ſun and air for a conſider-

able

able length of time. By these means it lost a great deal of its smell, and seemed to acquire a firmer consistence. The appearance of this substance was somewhat singular; for, on breaking it, we found little filaments running in every direction, exactly similar to the cellular substance between the muscular fibres. These pieces were then beaten to a fine powder, and on this powder was poured some diluted nitrous acid. After the acid had been on it for about an hour, a froth was formed at the top; the acid was then poured off, and the substance was repeatedly washed; it was then melted in hot water, and when it concreted it was of a very beautiful straw-colour, without the least offensive smell; on the contrary, it had the agreeable smell of the best spermaceti. May not this substance be applied as an article of commerce? great quantities of it may be obtained. It burns with a fine flame; and dead animals, which at present are of little or no use, may be changed into it. I am very sorry it has not been in my power to ascertain the precise quantity which may be obtained from

a given

a given quantity of flesh; but, from what I have obtained, I can say that it would be very considerable. The running-water carries off a great deal of it, but that might be obviated by the addition of strainers. Moreover, that which is carried off by the water is the purest, and I always take care to get as much as possible of it, because I find it gives me less trouble in purifying it. The water over the animals, and for some distance round them, is covered with a very beautiful pellicle, which is white in general; sometimes it refracts the sun's rays, producing the prismatic colours.

Fish may be also changed; and I recollect having seen in some old author, whose name I cannot recollect, a passage in which he mentions a circumstance where something of this kind happened in a whale. He says, that after this fish has been putrifying on the shore some time, the people have a secret by which they can procure and purify lumps, which they find to be similar to the spermaceti which they get in the usual way.

I have heard, from many people, obſervations which they had made where this ſubſtance had been formed, and which they could not account for; but, as the circumſtances were the ſame as thoſe before mentioned, I ſhall forbear giving additional trouble.

On ſeeing a body opened ſome time ago, where there was a great collection of water in the cavity of the thorax, I obſerved that the ſurface of the lungs was covered with a whitiſh cruſt. I remarked to a friend, that I thought this cruſt was owing to ſome combinations which had taken place between the lungs, or pleura, and the ſerous fluid effuſed, ſimilar to what I had obſerved between fleſh and water; or that the ſerous fluid had acted on the coagulable matter, and had produced a ſimilar change.

Dr. Cleghorn mentions a circumſtance, which in ſome meaſure ſeems to agree with the obſervation then made. As the fact is a curious one, I ſhall ſubjoin the following extract. He is ſpeaking of abſceſſes formed in the lungs. "Theſe "abſceſſes had ſometimes emptied themſelves "into

" into the cavity of the thorax, ſo that the lungs " floated in purulent ſerum; their external mem- " brane, and likewiſe the pleura, being greatly " thickened, and converted as it were into a " white cruſt, like melted tallow grown cold." In a note he ſays, " I am now doubtful if this " cruſt was the pleura and external coat of the " lungs, changed from a natural ſtate by ſoaking " in a purulent fluid, and if it was not altoge- " ther a preternatural ſubſtance, formed by fluids " depoſited on thoſe membranes, and compacted " together by the motion of the lungs."

Much has been ſaid by many authors on the ſubject of ſecretion. It was at one time ſuppoſed that it depended on ſome peculiar property of the living principle; and it was thought impoſſible to form any ſecretion but through the medium of ſecreting organs. M. Fourcroy has, however, contradicted this by the experiments where he forms bile.

Spermaceti is an animal ſubſtance, ſecreted in a particular ſpecies of whale; and the ſubſtance which is formed in the foregoing experiments, as

far as I can judge, agrees with it in every particular.

M. Fourcroy says, that M. Poulletier de la Salle found a crystalized inflammable substance, similar to spermaceti, in biliary calculi.

May not the suety matter in steatomatous tumours arise from something of this kind?

By attending to the various secretions of the body, by examining their composition in the healthy and morbid states of the system, may we not expect to derive great advantage, particularly when accurate experiments are applied towards the relief of disease?

Some excuse may, perhaps, seem necessary for the little attention which has been paid to accuracy in the results of the different experiments; particularly so, as the analysis of every part of the animal body, except the bones, is at present so incomplete; but I hope that the time necessary for my medical pursuits, and the want of a complete chemical apparatus, will not render the simple facts I have here related less useful.

I have

I have not attempted to account for the various phænomena which appear in the experiments, becauſe the facts ſeem too few to admit of any general concluſion.

If the above experiments ſhould appear to the Society worthy of their attention, the application of my former experiments, and the reſults of ſome which I hope to make, on ſome animals that are placed under different circumſtances favourable to their decompoſition, ſhall be the baſis of a future paper.

XXIV. *Conclusion of M.* Baumé's *Memoir on the Purification of crude Saltpetre.*

(from p. 137.)

On the Mother-water resulting from the Operation before described.

THIS mother-water contains the same substances as the crude saltpetre, but in different proportions. The pure saltpetre does not amount to above half the weight of the other saline substances. The whole of the sea-salt is collected in it, and almost all the earth. In the usual way, the mother-water is treated with potash, which decomposes the salts with an earthy basis, and forms saltpetre and muriat of potash. As it was my intention to examine this mother-water analytically, in order to discover what it contained, I operated upon some of it without pot-ash; another part I treated with pot-ash, that it might serve

ſerve by way of compariſon; of that I ſhall ſpeak hereafter.

I ſhall not deſcribe, in a particular manner, the various and ſucceſſive evaporations, cryſtalizations, and ſeparations of ſea-ſalt; ſuch deſcriptions of the ſame operation, many times repeated, would be as tedious in the recital, as the operations were troubleſome and tireſome to perform. I ſhall only ſay, that, as this mother-water was very turbid, I filtered it, to ſeparate the looſe earth; and then put the liquor to evaporate. It ſoon furniſhed ſea-ſalt, which I ſeparated as it was produced. When the liquor was ſufficiently evaporated, I filtered it, and ſet it by to cryſtalize. It produced ſaltpetre of a reddiſh colour, in which there was a mixture of a ſmall quantity of ſea-ſalt. I put this ſaltpetre to drain in a funnel, and ſprinkled over it a ſmall quantity of cold water, which took away the reddiſh colour, and diſſolved the ſea-ſalt.

I repeated the evaporation, the ſeparation of ſea-ſalt, the filtration, the cryſtalization, and the ſprinkling cold water upon the cryſtals, (to take away the colour, and diſſolve the ſea-ſalt

which

which had cryſtalized with the ſaltpetre), until the remaining liquor would furniſh no more cryſtals. Of this liquor there was about a pint; which I mixed with a pint of rectified ſpirit of wine, and expoſed the mixture to the cold. After ſome days, there formed, at the bottom of the veſſel, an ounce and a half of ſalt; which conſiſted of ſaltpetre and ſea-ſalt, the proportion of the latter being ſmalleſt.

I ſeparated theſe two ſalts from each other, and evaporated the ſpirit of wine, to procure the mother-water; of which there then remained fourteen ounces.

The whole quantity of pure ſaltpetre obtained from the mother-water, treated as above deſcribed, was eighteen ounces ſeven grains.

To avoid repetitions, I will deſcribe in the following part how I ſeparated the ſaltpetre from the ſea-ſalt.

Reſults from the forementioned Operations.

	ounces.	*gros.*	grains.	ounces.	*gros*	grains.
Saltpetre obtained from the firſt operation, -	51	4	9			
Ditto obtained from the mother-water, -	18	0	7	69	6	16
Ditto mixed with a very ſmall quantity of ſea-ſalt, - -	0	2	0			
Sea-ſalt, -	13	6	54	14	1	18
Ditto mixed with a ſmall quantity of ſaltpetre,	0	2	36			
Earth, in the whole, -				0	4	53
Mother-water, - -				14	0	0
				98	4	15
Loſs, - - -				1	3	57
				100	0	0

Analyſis

Analysis of one Hundred Ounces of the same crude Saltpetre as was used in the former Experiment, the mother-water being treated with fixed Alkali.

To complete my work, it was necessary that I should examine the crude saltpetre by analysis, and that I should treat the mother-water with fixed alkali, that I might know how much the quantity of saltpetre was increased by the said alkali.

I began by washing one hundred ounces of crude saltpetre, in the manner already described. By this means I separated that part of the saltpetre (about three fourths) which did not require any alkaline salt. This I purified as before, and obtained from it fifty-one ounces and three *gros* of perfectly pure, and very dry, saltpetre. I washed the earth which remained upon the filter, and dried it; it weighed fifty-eight grains. There remained about eight ounces of mother-water, which I mixed with that I had obtained by washing.

I first

I firſt filtered the mother-water, to collect the looſe earth; this I waſhed, and dried. It weighed one *gros*, twenty-four grains; which, added to that I had ſeparated from the waſhed ſaltpetre, amounted all together to two *gros*, ten grains, of looſe earth. The reſt of the earth is kept in ſolution by the mother-water.

I then heated the liquor, and added, by degrees, ſome dry and very pure fixed alkali, till I reached the point of ſaturation. It required, for that purpoſe, four ounces, two *gros*, and ſixty grains. The earth of the neutral ſalts with an earthy baſis was now precipitated. I filtered the liquor; it paſſed through the filter of a yellow colour. I waſhed the earth which remained upon the filter, till it was quite free from ſaline particles, and then dried it: it weighed two ounces, five *gros*, and fifty-two grains.

I united all the liquors, and evaporated them, till about a quart remained; during this evaporation a great deal of ſea-ſalt was precipitated. This ſalt I collected into a funnel, (the neck of which had a ſmall bundle of ſtraw in it,) that it might

drain. The liquor, being set to crystalize, furnished a quantity of saltpetre of a reddish colour, mixed with sea-salt. I put it to drain in a funnel, and washed it, by passing cold water over it, which took away the colour, and dissolved the sea-salt.

I repeated these evaporations and crystalizations several times, filtering the liquor each time, and washing the salt after every crystalization, to deprive it of colour, and to dissolve the sea-salt. I also took away the sea-salt, as it was separated by evaporation. At last there remained two *gros* of extractive mother-water.

I afterwards separated from the sea-salt the saltpetre which it had retained.

Results.

Results.

	ounces.	*gros.*	grains.	ounces.	*gros.*	grains.
Saltpetre obtained from the first operation, -	51	3	0	72	6	4
Ditto obtained from the mother-water, -	21	3	4			
Loose earth, - -				0	2	10
Sea-salt, - - -				19	5	60
Extractive mother-water, -				0	2	0
				93	0	2
Loss, - - -				6	7	70
				100	0	0

Remarks.

By means of the washing which the crude saltpetre undergoes, in the beginning of the foregoing process, it is freed from most of the foreign sub-

 stances;

ſtances; but there remains, as was ſaid before, a ſmall quantity of earth. This could not occaſion any embarraſſment in operating in the large way; it would attach itſelf to the ſides of the caldrons.

If the mixture of alkaline ſalt and mother-water is made without heat, the earthy precipitate (as in the preparation of lakes) takes up the greateſt part of the colouring-matter; but a portion of the earth is diſſolved by the fixed air which is diſengaged during the ſaturation, and appears again as ſoon as the liquor is heated in the ſmalleſt degree. If, on the contrary, the ſaturation is made with the aſſiſtance of heat, leſs of the colouring-matter is ſeparated, and the liquor does not become turbid till towards the end of the evaporation. It would be proper, in operations upon a large ſcale, to filter the liquors into caſks, after the precipitates are formed in them, and even a ſhort time only before the evaporation of them is completed, and they are about to be ſet to cryſtalize.

The ſea-ſalt taken from the mother-water, during the evaporations, is mixed with ſaltpetre. Theſe

These two ſalts muſt be ſeparated, that the weight of each may be known. Their ſeparation is accompliſhed by their different ſolubility in cold or hot water. Saltpetre diſſolves in hot water more readily than ſea-ſalt; and ſea-ſalt diſſolves more readily in cold water.

The ſea-ſalt impregnated with ſaltpetre is to be put into a ſilver ſaucepan, adding thereto a ſmall quantity of water, little more than ſufficient to cover the ſalt. The mixture is then to be heated, and the ſaltpetre will be diſſolved in preference to the ſea-ſalt; after which the liquor is to be decanted. This operation may be repeated ten or fifteen times, or more, until the ſea-ſalt remaining in the ſaucepan contains no more ſaltpetre. This may be determined by drying a little of the ſea-ſalt, and throwing it upon burning coals: if it ſhews any diſpoſition to melt, the waſhing it with water, in the manner juſt deſcribed, muſt be continued.

The liquor from the ſea-ſalt, though loaded with ſaltpetre, ſtill contains a portion of ſea-ſalt alſo. It muſt be evaporated, and operated upon afreſh,

afresh, in the manner already described. By these means, with patience and address, we may at least separate these salts from each other; without which it is impossible to obtain a perfect analysis.

The sea-salt in the crude saltpetre is found (as we have already said) in three different states. But I have also observed a fourth state, which has very singular properties; and which I at first thought was oxygenated sea-salt, but it does not detonate like that salt, when thrown upon live coals. I found abundance of this kind of sea-salt in the mother-water treated with pot-ash; it shews itself when the evaporation is nearly completed.

The following are the properties of this salt. It is much more soluble than either of the sea-salts with an alkaline basis; (I could not observe the form of its crystals, as the manner in which I obtained it is not favourable to crystalization;) it sinks and bubbles upon live coals without melting: it leaves upon the coals a neutral salt, which has a cold taste like the fusible salt of urine; concentrated vitriolic acid sets free from it, with great effer-

effervefcence, a ftrong fmell of oxygenated marine acid, or of aqua regis; the vapours produced have a reddifh caft.

In another fimilar operation I had remaining about two ounces of thick brown mother-water, which contained a great deal of this falt, and alfo a fmall quantity of faltpetre, which it was impoffible to feparate by cryftalization. I dried a very fmall portion of this mother-water in a filver faucepan, in hopes of deftroying the extractive part by heat; but, when the matter had acquired a certain degree of drynefs, it fuddenly inflamed, and jumped out of the faucepan, more than fix feet high, with a ftrong explofion. A fmall quantity of the matter which remained in the faucepan appeared to be fixed alkali.

The analyfis of this faltpetre with alkaline falt exhibit products which differ fo much from thofe of that made without it, as to deferve confideration. This difference, however, is only in the products of the mother-water. The quantity of faltpetre I obtained from the firft operation was nearly the fame in both experiments.

The

The mother-water, treated with four ounces, two *gros*, and fixty grains, of alkaline falt, yielded eight ounces, fix *gros*, and thirty-two grains more of faline fubftances than that treated without alkaline falt; of which, three ounces, two *gros*, and fixty-nine grains, were faltpetre; and five ounces, four *gros*, and fifty-two grains, were fea-falt. It is obvious that this increafe is owing to the decompofition of the falts with an earthy bafis. As it is fuppofed that as great a quantity of alkali, (in weight,) as of dry acid, enters into the compofition of faltpetre, and of fea-falt, a certain portion of the alkali was employed in producing the increafe of the faltpetre obtained; and the reft of the alkali, which was the greateft part thereof, was employed in decompofing the calcareous fea-falt, and in forming muriat of pot-afh; which being a falt of no value, this part of the alkali is intirely loft. It would therefore be of great advantage to difcover a method by which the calcareous fea-falt might be feparated from the mother-water, before the alkali is added; as, in that

cafe,

case, all the alkali made use of would form saltpetre only.

I have discovered a method of doing this, and mean to make it the subject of a paper which I am now preparing to write. I also hope to be able, in consequence of this discovery, to establish a method of analysing crude saltpetre, which shall be free from the inconveniences attending that commonly made use of.

XXV. *On the Action of the Fluor-acid upon filiceous Earth, and on the Application of that Property to engraving upon Glafs.* By M. de PUYMAURIN.

From the Memoirs of the ACADEMY of SCIENCES, &c. of TOULOUSE.

THE fluor-acid is procured from a faline ftone, known by the name of fufible fpar, fluor-fpar, falfe amethyft, &c. Chemifts were ignorant of the nature of this mineral, and confounded it with the felenitic fpar; but miners, in confequence of their practice, diftinguifhed it therefrom, by its ufeful property of ferving as a flux to the moft refractory ores.

Marggraf was the firft who examined fufible fpar, and felenitic fpar. He foon determined their different characters; and, having remarked that a mixture of fufible fpar with vitriolic acid corroded

corroded the glaſs of which retorts were made, and that a particular kind of earth was volatilized with the acid made uſe of, he conſidered the property of being volatilized by acids as the eſſential character of the fluor-ſpar.

Prieſtley, who ſought for aëriform fluids in every ſubſtance, firſt obſerved, that an acid gas was diſengaged in the diſtillation of this ſpar with vitriolic acid, which communicated to water, as ſoon as it came into contact with it, a ſtrong degree of acidity, and covered the ſurface of the water with a ſtony cruſt. At the firſt diſcovery of this new being, he could not attribute the acidity of the water to any thing but its combination with the vitriolic acid, partly volatilized by phlogiſton, and partly ſaturated by a portion of the earth of the ſpar, which precipitated itſelf as ſoon as it came into contact with the water.

It was reſerved for a man as learned as he was modeſt, and one whoſe every work contains a diſcovery, to find in a ſtony, inſipid, and indiſſoluble, ſubſtance, a moſt penetrating acid, which eaſily mixes with water, and which alone

 poſſeſſes,

possesses, in an eminent degree, the remarkable property of dissolving siliceous earth.

Scheele, in 1771, presented to the Academy of Stockholm the result of his experiments upon fusible spar. He discovered the acid of its basis, and assigned it the rank it was entitled to among the mineral acids. He continued a labour as new as interesting, and thereby corrected those errors which the singular circumstances attending his experiments at first led him into. Being attacked at the same time, in two different manners, by Messieurs Monnet and Boullanger, he refuted their systems, and settled the different degrees of affinity of his new acid to various substances. Lastly, in the year 1786, already on the brink of the grave, he victoriously replied to M. Achard, and shewed us how we might in future obtain the fluor-acid pure, and without any mixture.

I had already made many experiments upon the decomposition of glass by means of the fluor-acid, when I read, in the new *Encyclopédie Méthodique*, the experiments of Messieurs Wiegleb and Bucholz upon the same subject. From that time I considered mine as useless, and I shall therefore only

only mention the loss of weight suffered by the various small glass retorts I made use of. I found in the receiver (in the form of a jelly which had the appearance of chalcedony) the quartzose earth which had been separated from the glass of the retorts; each of which had contained two ounces of sulphuric acid, and one ounce of fluor-spar.

	First Retort.			Second Retort.			Third Retort.			Fourth Retort.		
	oz.	*gros.*	grs.	oz.	*gros.*	grs.	oz.	*gros.*	grs.	oz.	*gros.*	grs.
Weight before the distillation,	1	7	5	1	3	36	1	2	7	1	3	54
Weight afterwards, -	1	5	35	1	2	0	1	1	23	1	2	36
Loss of weight,	0	1	42	0	1	36	0	0	56	0	1	18

Two other retorts, of the same size, were exposed to a more violent fire. Not only the interior surface of the upper part of them was corroded, but the inferior part was in holes, and so much damaged, that I could not exactly compute how much they had lost in weight.

When the fluor-acid is obtained from a mixture of fluor-spar and vitriolic acid in a naked fire, and in a glass retort, it is rendered impure

in

in two different ways. It is saturated with siliceous earth, which it holds in solution, and it is mixed with sulphuric and sulphureous acids. The presence of these is immediately shewn by the acetite of Barytes. To obtain the fluor-acid pure, we must follow Scheele's process; that is to say, we must distil the mixture in a retort made of lead, or of tin, and cover the inside of the receiver with a coat of wax.

The distillation of a mixture of four ounces of fluor-spar and twelve ounces of sulphuric acid, in that way, is sufficient to render acid eight ounces of water. The acetite of Barytes does not then discover any mixture of sulphuric acid, though the acid obtained by the distillation is strong enough to dissolve calcareous earth with effervescence *. It also changes vegetable colours, but does not destroy them. Having let some drops of this acid fall upon a pair of silk stockings, of a blue grey colour, yellow spots were formed, which disappeared merely by washing. It must not,

* This acid must be kept in flint-glass bottles, coated internally with a mixture of wax and oil.

however,

however, be thought that the acid, when obtained this way, is quite pure: it is mixed with a ſmall quantity of oxide of lead, or of tin, according to the retort made uſe of. I have precipitated the metal by volatile alkali, and reduced it into its original form of lead, or tin.

I diſtilled in a ſmall retort of lead, in a water-bath, two ounces of vitriolic acid and half an ounce of fluor-ſpar.

The retort weighed eleven ounces eight *gros.* In the firſt diſtillation, it loſt one *gros* and a half; in the ſecond, one *gros*; and, in the third, fifty-eight grains. The acid obtained was whitiſh, and had a ſtrong ſmell of liver of ſulphur. The fluor-acid alone cannot diſſolve tin, or lead; but, during the diſtillation, the ſuperabundant ſulphuric acid diſſolves theſe metals. Being deprived of its oxygene, it forms an earthy hepar with the calcareous earth of the ſpar; while the fluor-acid diſſolves, and takes up, the metallic calx or oxide.

In this diſtillation we muſt never exceed the heat of boiling water, becauſe the ſulphuric and ſulphureous acids would, in that caſe, paſs into the receiver with the fluor-acid.

Having

Having been able, by this procefs, to procure the fluor-acid intirely deprived of fulphuric and fulphureous acids, I fubmitted various fubftances, fome metallic and fome filiceous, to its action; and am perfuaded that the difference obferved by fome chemifts, in the refults of fimilar experiments, arofe only from the different quality of the acid made ufe of.

I put into two phials an equal quantity of fluor-acid and filings of iron. The acid put into the firft phial had been obtained by diftillation in a glafs retort, and, if mixed with acetite of Barytes, would reftore the Barytes. The acid of the fecond phial had been made according to Scheele's procefs, before defcribed.

TO BE CONCLUDED IN OUR NEXT.

REPERTORY
OF
ARTS AND MANUFACTURES.

NUMBER XXVIII.

XXVI. *Specification of the Patent granted to Mr.* JOSEPH BRAMAH, *of Piccadilly, in the County of Middlesex; for his Invention of Locks upon a new Construction.*

WITH TWO PLATES.

Dated April 3, 1784.

TO all to whom these presents shall come, &c. NOW KNOW YE that, in compliance with the said proviso, and in pursuance of the said statute, I the said Joseph Bramah do hereby declare, that my said invention is composed and made in man-

ner following; that is to ſay, the principle of all locks hitherto known, or in public uſe, is too well underſtood to require any particular deſcription here; yet it may not be improper to obſerve on what ideas their ſecurity was always founded, and likewiſe how far ſuch principle may tend to render them perfect or effectual; by which may be obtained ſome comparative information, neceſſary to ſhew or explain the advantages and ſuperior utility of this my ſaid invention. The means hitherto adopted for the ſecurity of all locks are, the inſerting or fixing, between the key-hole and the bolt, a greater or a leſs number of wheels or wards; which ſaid wheels or wards may be croſſed or interwoven, in ſuch a manner as to render the communication between the key-hole and the bolt as irregular and crooked as poſſible, in order to prevent the ſaid bolt from being moved by any counterfeit application when the key is abſent; the bit of which ſaid key is ſo cut or ſhaped as to form a complete tally with the ſaid wheels and wards, and is thereby capable of producing the required effect, when applied for the purpoſe of moving the bolt. Now the inſufficiency of this

method

method of rendering locks a perfect ſecurity is as follows; *viz.* notwithſtanding the ſaid wheels and wards may be variouſly placed and diſpoſed, yet they cannot by any means become ſufficient to anſwer the intended purpoſe, owing to their being always left fixed in the lock. Their form and diſpoſition can be eaſily obtained by impreſſion; ſo that, notwithſtanding they may prevent the uſe or effect of picklocks, yet the making a perfect or ſkeleton key is always extremely practicable. And farther, the variations capable of being made in the diſpoſition of the ſaid wheels or wards, and the form of the key's bit, are not ſufficient to produce the required number of locks, without having great quantities exactly alike, and their keys capable of opening each other reciprocally; from which they become a very imperfect ſecurity, as any ill-diſpoſed perſon may, by furniſhing himſelf with a number of old keys, be enabled to open almoſt all the common locks in the kingdom, with as little difficulty as if he had in his poſſeſſion the key belonging to each lock. To remedy theſe objections, by diſcovering ſome principle or method whereby the ſucceſs of pick-

locks, falſe keys, and all other counterfeit means of opening locks, may be infallibly prevented, has been the ultimate deſign of my ſaid invention, and may be effected in manner following; *viz.* inſtead of introducing (for the ſecurity of the bolt and other movable parts of the lock) a number of wards and wheels, I have found out and invented much more ſimple and effectual means of rendering the ſaid bolt and other parts entirely immovable, without the abſolute application of the real key; by thoſe ſaid means, the effects of pickloaks, the practicability of obtaining the form of the key, and the having a number of the ſaid keys alike, are entirely avoided, by having a greater or leſs number of movable parts, ſuch as levers, ſliders, &c. adapted and placed in the lock, ſo as to require each of them a ſeparate and diſtinct change in their ſituation and poſition, before the bolt, and other parts of the lock on which its ſafety depends, can be ſet at liberty or moved. Theſe ſaid levers, ſliders, or other movables, by the aſſiſtance of an elaſtic, gravitating, or other power, have the property of maintaining, or reſtoring, their given poſition or ſituation,

tion, after it may have been deſtroyed by any forcible application for that purpoſe. From this ſaid property, the ſaid levers, ſliders, or other movables, are rendered capable of receiving (as it were) any impreſſion or required change in their poſition or ſituation, correſpondent to the cauſe which produces ſuch ſaid change, and are alſo thereby always reſtored to their former ſtate, or reſting ſituation, when the ſaid cauſe is withdrawn; ſo that the opening theſe my ſaid invented locks is as difficult as it would be to determine what kind of impreſſion had been made in any fluid, when the cauſe of ſuch ſaid impreſſion was wholly unknown; or to determine the ſeparate magnitudes of any given number of unequal ſubſtances, without being permitted to ſee them; or to counterfeit the tally of a banker's check, without having either part in poſſeſſion. The form of theſe ſaid levers, ſliders, or other movables, and alſo the manner of fixing them in the lock, may be varied without end, without altering or loſing any of the intended properties or advantages, as the principal merits and efficacy of my ſaid invention do no ways depend thereon, but entirely depend on the

the ſaid levers, ſliders, and other movable parts, being ſo fixed or diſpoſed as to prevent the bolt, or other parts of the lock on which its ſafety depends, from being moved, without the ſaid levers, ſliders, or other movables, firſt receiving each of them a ſeparate and diſtinct change in their poſition or ſituation, by a key or other contrivance for that purpoſe; which, being puſhed or preſſed in a progreſſive direction, without revolution, againſt ſome part of each of the ſaid levers, ſliders, &c. occaſions them to change their poſitions, in manner exactly correſpondent to the part of the key ſo applied. And the ſaid part, being formed with a number of irregular ſurfaces, equal to the number of levers, ſliders, &c. againſt which it is puſhed or preſſed, cauſes them to move at different times, and to different diſtances from their original ſituation. And the ſaid key, by having a ſtop, or ſome mark whereby to limit or determine the length of its puſh againſt the ſaid levers, ſliders, &c. puts a period to each of their motions, notwithſtanding they are at liberty to move farther, but are prevented by the reſiſtance of a ſpring, gravity, or other power,

always

always endeavouring to reſtore them to their original ſituation. So that the motion of each lever, &c. ſeparately, depends on the height or depth of that ſurface of the key againſt which it falls. So that a perfect tally is formed, ſimilar to any impreſſion made in a ſoft body by the forcible application of any harder one; which ſaid hard body repreſents the eſſential part of the key, and may be of any determinate ſhape, formed by rule or by accident; and the moving the bolt, or other parts of the lock whereby it may be opened, entirely depends on the poſitive motion of the ſaid levers, ſliders, &c. as any one of them would, by being puſhed the leaſt degree too much or too little, entirely prevent the bolt, &c. from being moved, or ſet at liberty. And, as the whole of the ſaid levers, ſliders, &c. are reſtored to their reſting ſituation when the key is withdrawn, by the properties or powers above mentioned, the ſaid tally or impreſſion is then totally deſtroyed, and conſequently the opening of the lock is then left wholly dependent on chance, whilſt the ſaid key is abſent, as there is no rule whatever, nor imagination founded on certainty, that may in the leaſt

degree

degree tend to aſſiſt in diſcovering the required poſition or ſituation of each or any of the ſaid levers, ſliders, or other movables, whereby the form of the key, or the part of the ſaid key neceſſary to the opening of the lock, might be aſcertained. Now, admitting that no lock on this ſaid principle can be picked, or the form of the key obtained, their farther ſecurity then depends on the number of different keys that may be made without having any two of them alike, which number I truſt will appear indeterminate from the following demonſtration; *viz.* let us ſuppoſe the number of levers, ſliders, or other movables by which the lock is kept ſhut, to conſiſt of twelve, all of which muſt receive a different and diſtinct change in their poſition or ſituation by the application of the key, and each of them likewiſe capable of receiving more or leſs than its due, either of which would be ſufficient to prevent the intended effect; it remains therefore to eſtimate the number producible, which may thus be attempted, *viz.* let the denominations of thoſe levers, &c. be repreſented by twelve arithmetical progreſſionals, we find that the ultimate number of

of changes that may be made in their place or ſituation is 479,001500, and by adding one more to that number of levers, &c. they would then be capable of receiving a number of changes equal to 6227,019500, and ſo on progreſſively, by the addition of others in like manner, to infinity. From this it appears that one lock, conſiſting of thirteen of the ſaid levers, ſliders, or other movable parts, may (by changing their places only, without any difference in motion or ſize) be made to require the ſaid immenſe number of keys, by which the ſaid lock could only be opened under all its variations; wherefore it likewiſe appears that the ſaid number of locks may be made, conſiſting of the ſame parts, without the ſmalleſt difference whatſoever, and, by varying the places of ſuch ſaid parts, would require each of them a ſeparate key, and not one out of the whole number above mentioned be capable of opening any lock, except that particular lock to which it belongs. Now it muſt be obſerved, that the number of different locks above ſtated is produced by thirteen movables, (to wit,) levers, ſliders, &c. which, having all a diſtinct difference in their re-

quired motions, determines their denominations or names, without any relation being had to the ſeparate value or poſitive motion of each, which ſaid motion may be given at diſcretion; ſo that it plainly appears that the number producible from a like number of levers &c. is far from terminating here, as their motions, and the difference in proportion one to another, may be varied without end, and are to be added to the former; it is therefore very obvious, from this demonſtration, that a much leſs number of the ſaid levers, ſliders, or other movables, will be found ſufficient to produce any required number of the ſaid locks, without having any of their keys to paſs each other. Theſe ſaid levers, ſliders, or other movables above mentioned, may be adapted and applied to all ſorts of diſcretionary faſtenings whatever, ſuch as bolts, bars, turn-buckles, &c. The figures or drawings hereunder written, or hereunto annexed, together with the demonſtration or deſcription therewith given, will more fully ſhew the true nature and intent of this my ſaid invention. In witneſs whereof, &c.

Before

Before I refer to the drawings, I think it proper to obſerve, that the art of conſtructing locks wholly depends on ſome method or means, ſo adapted or contrived as to be rendered capable of admitting or preventing, at diſcretion, the motion of ſome faſtening, ſuch as bolt, bar, or other movable part; which may be made of iron, braſs, wood, or other materials ſufficient for the purpoſe. I therefore flatter myſelf that the drawing, Fig. 1, (Plate XII,) will be fully ſufficient to ſhew the true nature and deſign of this my invention. G repreſents a ſliding bar or bolt, in the frame K, that hath cut in its edge ſix notches of any proper depth. In theſe notches are placed ſix ſliders or ſmall bars A B C D E F, that are ſunk into the bottom of each notch, ſo that the motion of the bar or bolt G is thereby totally prevented, till theſe ſliders are moved ſome way or other to give it liberty; which muſt be done from their ends at I I, as no other part of them is meant to be expoſed for the purpoſe of moving them; which ends at I I always have an equal projection when the bar G is ſet faſt. Now we will ſuppoſe each of theſe ſliders capable of being

puſhed upwards towards A B &c. to any determined diſtance, and, when each of them has exactly received its due motion, the bar G is ſet at liberty, ſo as to ſlide backwards and forwards as required. Now, in order to determine the ſeparate and diſtinct motion that ſhall be given to each, we will ſuppoſe the part H to be made; which part ſerves to repreſent a key, and the ends 1 2 3 4 5 6 are cut of different lengths, either by rule or by chance, ſo that, when puſhed againſt the ends of the ſliders at I I, they will cauſe each of them to be ſlided up at different times, and to different diſtances, from I I, in a form exactly correſpondent to the ends of the part H. When they have thus received their correſpondent poſition, and their ends at I I form a complete tally with the part H, by making a notch in each ſlider at 1 2 3 &c. in a line with the bar G, the ſaid bar will then have liberty to be ſlided backwards and forwards without obſtruction; and, when brought into its original ſituation, and the part H withdrawn, the ſliders A B C &c. will then fall down into their notches, and faſten it as uſual; and their ends at I I will be reſtored per-

fectly

fectly even as before, and not the leaſt trace left of the poſition required in them to ſet the bar G at liberty; it depends therefore entirely on chance, when the part H, or key, is abſent. (See ſpecification.) The conſtruction of the Fig. 1 is thus adapted for the more eaſy conveying the true ideas of this invention. Theſe ſliders A B C &c. may alſo be made ſo as to have their required motion or poſition given them, without the uſe of H, by having ſundry changeable marks graduated on the edge, or other part of each of them expoſed for that purpoſe, as at O O; certain of which are to be brought in contact, or in a line, before the notches 1 2 3 &c. will be oppoſite to each other, or the bar G moved; and the ſaid marks or graduations required may be diſtinguiſhed by figures, characters, &c. and the ſecret will ſerve as a key to ſuch as are in poſſeſſion thereof. (For the changes producible in this number of ſliders, or other movables, ſee ſpecification.)

Fig. 2 is meant only to repreſent in what manner ſliders may moſt conveniently be applied in locks of all ſorts. A is a frame or barrel that moves the bolt by its turning, in which barrel or frame

are fixed eight, or any other number of ſliders. B is a thin plate fixed in the lock, through which the barrel or frame A paſſes, and is prevented from turning for the purpoſe of moving the bolt, by the projecting parts of the ſliders that move in the fixed plate B, till the notches in each of them are, by the application of the correſpondent part of the key, puſhed into contact, or in a line with the plate A. At the end of each ſlider, in the cylindrical parts C C C &c. is fixed a ſpiral ſpring, which always reſtores them after the key is withdrawn, ſimilar to A B C &c. by their own gravity, in Fig. 1.

Fig. 3 repreſents a method of fixing any number of levers for the ſecurity of the part that moves the bolt, which part is B, and is fixed to the levers C C &c. as in the ſection. A A A is the plate, and other fixed parts of the lock, D is the drill-pin, on which the key is applied. *e* is the ſpring that reſtores the levers, after having been preſſed down by the key. The notches in the head of each lever are made by the rules already deſcribed. An endleſs variety of other modes may be adopted, of placing levers, ſliders,

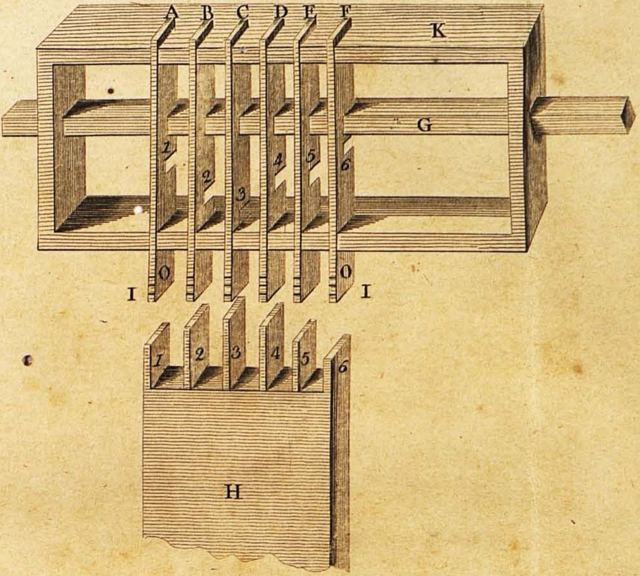
or

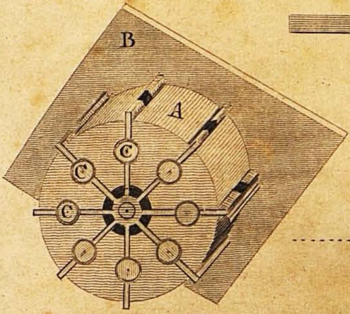
or other movable parts, in order to effect the above purpoſes, without in the leaſt degree deviating from, or loſing any of the eſſential properties ariſing from, the ideas of this invention. A, Fig. 4, (Plate XIII,) repreſents a lock that locks on both ſides. B is the bolt. C is the lower plate, in which the projecting part of the ſliders moves, for the purpoſe of ſecuring the bolt; *e e* &c. are the ſliders. D is the barrel or frame, repreſented in Fig. 2, in which the ſliders are fixed. F F &c. are the cylindrical parts in which the ſpiral ſprings act. G is the key-hole, which is bored through the center of D, as ſhewn in the ſection; into which hole the edges of the ſliders project, in order that the end of the key may fall againſt them when puſhed forward in the hole G. H is a part joined to the barrel or frame D, and acts as a key's bit to move the bolt, when D is turned round for that purpoſe. I is the ſection, where the barrels, ſliders, &c. are marked the ſame as in the plan. K K is the key from both ſides, on which there is a ſmall ſtump at L, that falls into a notch or ſlit in the barrel D, in order that D may be turned round with the key, for the

the purpoſe of moving the bolt; and alſo, by its turning under the cap M, the key is prevented from being puſhed out by the ſprings whilſt it is revolving to move the bolt. The end of the key is formed with different ſurfaces, which gives the ſliders different motions, (ſee ſpecification,) and brings the notches in the ſliders, when puſhed down to its ſtop, exactly in a line with the cover plate C; which notches, being the ſize of the thickneſs of the ſaid plate, permit the barrel D to make a revolution, if required; and it appears from this ſection, that as the ſliders *e e* &c. may each of them be puſhed as far as the bottom of the ſlit or groove *n n*, in which they move, the whole of the notches in the ſliders are liable to be puſhed too far as well as too little, both of which would prevent the barrel D from being turned, or the bolt B from being moved.

XXVII.

Fig. 1.





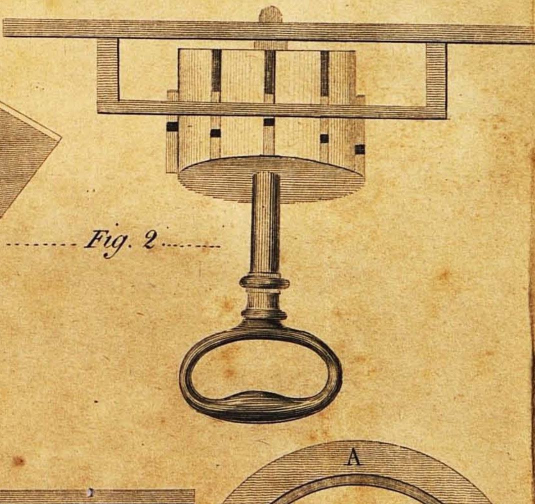
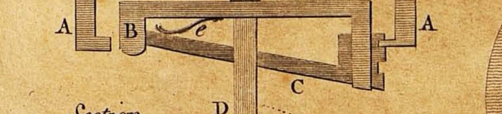
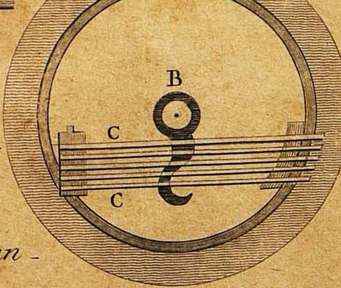


Fig. 2



Section

Fig. 3.



Plan

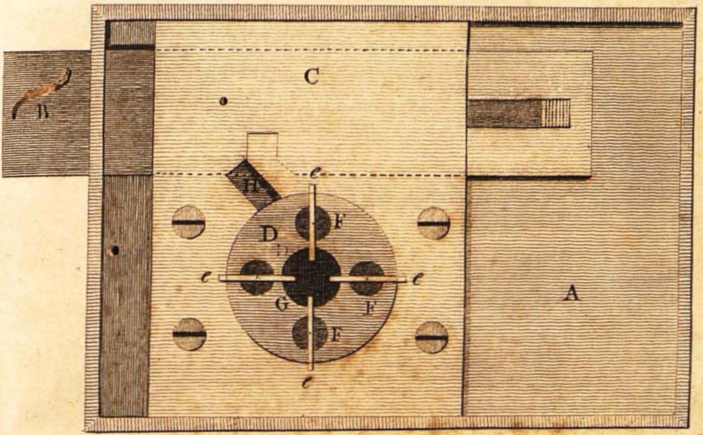
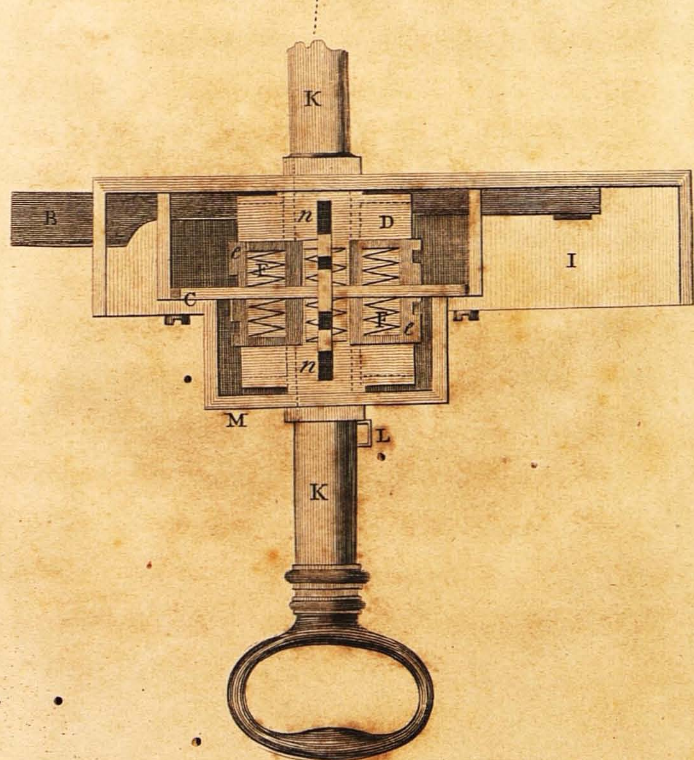


Fig. 4.



XXVII. *Specification of the Patent granted to Mr.* SAMUEL BIRNIE, *of the City of Glasgow, Refiner of Lead; for his Method of preparing and restoring the Calx of Lead, after being used in extracting the mineral Alkali from common Salt, by which means a great Quantity of mineral Alkali may be extracted to Advantage from common Salt.*

Dated August 12, 1788.

TO all to whom these presents shall come, &c. NOW KNOW YE that, in compliance with the said proviso, I the said Samuel Birnie do hereby declare, that the method I have invented for preparing a calx of lead, for extracting the mineral alkali from common salt, or other purposes, consists in extracting the silver from the lead by the following process; *viz.* the lead is put into a calcining furnace, and calcined with a moderate heat, until it is all or most of it converted into a calx. The calx is then to be melted, without addition, either in the same or in another furnace; when the calx becomes fluid, the silver, and what lead may be still in a metallic state, will sink to the bottom,

bottom, and be thus feparated from the calx. By repeating in this manner the calcination and melting, all the lead will thus be converted into a calx, and the filver obtained at laft pure. Or the filver may be purified from the laft portion of lead by the common procefs of cupellation or refining. Or, in place of again calcining by itfelf the metal got by the firft melting of the calx, it may be calcined with a quantity of frefh lead, and the calx melted as formerly; and this procefs may be repeated at pleafure; the filver being purified at laft, as above directed. Or the calx, prepared as above, may firft be ufed in extracting the alkali from common falt, and afterwards melted to extract the filver. And the method I have invented of reftoring or reducing again into lead the above calx, litharge, minium, or any other calx of lead, which has been ufed in extracting the mineral alkali from common falt, or which has by any method whatever been combined with the marine acid, confifts in adding to the above calx a fubftance or fubftances which have a ftrong attraction for the marine acid; by which means the acid is prevented from volatilizing and carrying off with it, in the procefs of reduction, a confi-

derable

derable portion of the metal, which it always does when the calx is reduced, according to the common method, without any other addition than an inflammable ſubſtance; this is done in the following manner, *viz.* to ſixteen parts, by weight, of the above calx add one part of lime, or a greater or a leſs proportion; they may be mixed either before or after they are put into the reducing furnace; the reduction is then to be performed in the uſual and common method in practice, by adding to the above mixture, pit-coal, charcoal, or any other convenient inflammable ſubſtance. Or, in place of lime, chalk may be uſed, common limeſtone, the ſhells of fiſh, or any calcareous, abſorbent, or other ſubſtance, capable of ſeparating, with the aſſiſtance of heat and an inflammable ſubſtance, the marine acid from the calx of lead. The lime, or other calcareous or abſorbent ſubſtances uſed in the reduction, will form, with the marine acid, a marine ſalt with an earthy baſis; which may be obtained from the ſlag which remains after the reduction, by adding water to it, decanting or drawing off the clear liquor, and then evaporating it to dryneſs. In witneſs whereof, &c.

XXVIII. *Specification of the Patent granted to Mr.* ROBERTSON BUCHANAN, *Engineer, and Overseer or Manager of the Cotton-Mills of Rothsay, in the Isle of Bute, Scotland; for his Invention of a Pump for raising Water in various Situations, but more particularly on-board Ships; and which may be occasionally converted into an Engine for extinguishing Fire, &c.*

WITH A PLATE.

Dated March 8, 1796.

TO all to whom these presents shall come, &c. NOW KNOW YE, that I the said Robertson Buchanan, in pursuance of and compliance with the said proviso, in the said letters patent contained, and the purport and true intent and meaning thereof, and of his Majesty's said most gracious intentions, do by this instrument in writing, under my hand and seal duly executed, describe and ascertain the nature of my said invention, and in what manner the same

ſame is to be performed, as follows; that is to ſay, this pump, like the common pump, acts by the preſſure of the atmoſphere; but differs from it in ſome particulars hereafter expreſſed, and has the following advantages. Firſt, the water is diſcharged from this pump through two valves; the one called the inner valve, ſituated on the bore of the ſuction-piece, through which the water on raiſing up the piſton firſt paſſes, and thence is communicated, by means of an aperture in the ſide of the pipe, to the ſecond or outer valve, which is placed at the bottom of the ciſtern, whence it paſſes into the ſpout. Secondly, the outer valve is not only within the command of a perſon's hand, and may be at all times cleared, but is made ſo as to afford a communication to clear the inner valve. Thirdly, theſe valves, not being confined to any particular dimenſions, are made large enough to admit any body or ſubſtance through them that is capable of paſſing through the ſuction-piece; and, being placed near to each other, and in an inclined poſition, gravel, dirt, or other things, cannot eaſily lodge in the pump, and the water is thus reſiſted or wire-drawn

drawn as little as poſſible in paſſing through the valves; and the pump is thus alſo made not liable to choke, or to have any unneceſſary tear and wear of its parts; but the valves may alſo be placed horizontally, or in any other poſition, when circumſtances require it. Fourthly, from the ſize and ſituation of the valves, they may be at all times eaſily taken out, ſo that they may without difficulty be readily repaired or renewed. Fifthly, this pump may be occaſionally uſed as an engine for extinguiſhing fire.

Theſe are the advantages which diſtinguiſh this pump, but the following inſtructions in regard to its conſtruction will more fully explain its nature and principle; though the principle of the invention, in the particulars above mentioned, may be obtained by various modes of conſtruction, provided the arrangement and diſpoſition of its parts here mentioned are preſerved.

This pump in its body and parts is made of wood, copper, caſt iron, or any other metal or material ſuited to ſuch purpoſes, or partly of wood and partly of metal, but metal is recommended for the parts above deck on-board ſhips;

and

and it is varied in form and dimenſions, as ſituation and circumſtances require. The valves beſt ſuited to the purpoſes of this pump are of the kind called clack-valves. Their apertures are made of any form or ſhape, and of any dimenſions; but the elliptical form is the beſt, becauſe it has been found that, where the apertures are of this ſhape, the valves loſe leſs water at each ſhutting than when the apertures are of a circular form; and the apertures ought to be made as large as the bore of the ſuction-piece, becauſe where the apertures of the valves are of the ſame dimenſions with the bore of the ſuction-piece, the water will be thereby leſs reſiſted or wire-drawn in paſſing through the valves. The valves may be made of any metal, but braſs is recommended as leaſt liable to ruſt.

A flat piece of leather is fixed on the under part of the lid, to render it elaſtic. The lid of each of the valves turns upon two pivots, which have freedom in their ſockets to riſe a little upwards, that any ſmall ſubſtance which happens to intervene near the hinge may not prevent the lid from lying cloſe to the box. The bore of the

lower

lower or ſuction-piece may be made of any ſhape and dimenſions, but, for the reaſon above mentioned, it is beſt made of the ſame ſhape and dimenſions with the aperture of the valves. For the purpoſe of allowing a more eaſy paſſage to the water, and for the better diſcharge of oblong pieces of wood and other things which may be brought up along with the water, the bore of the ſuction or lower pipe ſhould, when the inner valve is inclined, receive a bended or curved form as it approaches the inner valve, ſo as to make its ultimate direction nearly at right angles to the inclined poſition of the inner valve. From the loweſt extremity to the ſuction or lower pipe, a reticulated grate, extending ſome feet upwards on the outſide of the pipe, leaving a vacant ſpace between the outſide of the pipe and the inſide of the grate, may be fixed with advantage, in ſituations where there is any danger that large quantities of dirt, chips, gravel, or ſuch like ſubſtances may lodge in the well, and choke the lower extremity of the pipe; for, where this grate is ſo placed, although the lower extremity of it ſhould be choaked, the water will find a free paſſage, through

through the openings of the grate above the dirt, gravel, or other ſubſtances ſo lodging, to the lower extremity of the pipe. The inner valve is placed below the piſton; that is, as near the lower extremity of its ſtroke as the nature of the thing will admit, and is fixed by a reſt or rabbet, made in the periphery of the bore, or by any other means moſt convenient; and, when the pump is made of wood, it is introduced to its place by an aperture in the ſide of the pipe, to allow the water a paſſage to the outer valve. The outer valve is, in this caſe, fixed in a frame or piece of wood which covers this aperture, to which the outer valve is placed oppoſite. The frame or piece of wood containing the outer valve is encloſed by a ciſtern, with or without a movable lid, for the purpoſe of keeping water above the outer valve when the pump is in action; and the water is diſcharged from the ciſtern by a ſpout, placed at a height ſufficient to keep the outer valve covered with water when the pump is in action. A triangular piece of wood is faſtened on each ſide of the inſide of the ciſtern, to ſecure or hold the

 frame

frame or piece of wood containing the outer valve, and the triangular pieces of wood are kept tight by interpofing tar, tallow, or any other fimilar fubftance. Thefe triangular pieces of wood are eafily removed as occafion may require; and the frame or piece of wood containing the outer valve may be taken off, when the inner valve is in need of repair, or when a more free accefs is wanted to it than the aperture of the outer valve admits of. The above is the mode of fixing the outer valve, when the pump is made of wood; and, when made of wood, the working-barrel fhould be lined with brafs, to leffen friction. But, when the pump is made of copper, caft iron, or other metal, lining the working-barrel with brafs is unneceffary; and the outer valve is fixed in the fide of the pipe, without being contained in a movable frame or piece of wood, and the triangular pieces of wood mentioned above are unneceffary; but, in order to introduce the inner valve, and afterwards to get at it, when in need of repair, the barrel is faftened immediately above the valves by means of a flanch. For the purpofe of letting

fuch

ſuch part of the air eſcape (which is collected in what is called fetching the water) as does not find its way through the outer valve, a ſmall air-valve is placed, either in the piſton, or between the lower extremity of its ſtroke and the inner valve; but it is placed in the piſton with beſt effect, for the purpoſe of letting up a little water to aſſiſt in keeping the piſton air-tight. This air-valve, however, is not abſolutely neceſſary in either ſituation; for, the piſton may be made ſo pliant as to allow the remainder of the air ſo collected to eſcape around its circumference; and, in all caſes where the water is to be raiſed only a little height, this air-valve is unneceſſary. Motion may be given to this machine by means of the common brake, or by what are commonly called bell-ropes, or by ropes led horizontally from a bended lever, or by any other method practiſed in working the common pump, which it reſembles, except in the particulars above ſtated. In order to render this pump occaſionally uſeful as an engine for the purpoſe of extinguiſhing fire, it is only neceſſary to make the piſton air-tight in deſcending as well

as in afcending, and to fix to the ciftern an air-veffel communicating with pipes, in fuch manner that the ciftern is made air-tight in every part, excepting where it communicates with the air-veffel. No particular method of rendering the pifton air-tight is effential to this pump; all or moft of the methods in common ufe may therefore be applied to it. The air-veffel may, without any inconvenience, remain fixed to the ciftern at all times, which will be an advantage, as the pump can thus, when neceffary, be inftantly applied to the extinguifhing of fire. For the more fully underftanding the conftruction of this machine, both in its operation as a pump, and as an engine for extinguifhing fire, drawings are annexed, (fee Plate XIV,) having references to the different parts, the paper containing which drawings is figned by me as relating thereto. In witnefs whereof, &c.

Ex-

Explanation of the Figures.

(See Plate XIV.)

Fig. 1 is a vertical section of the pump, in which the suction-piece is only so far delineated as is necessary for illustration.

A is part of the suction-piece.

B the inner valve.

C the outer valve.

D the barrel.

E the piston.

F the cistern.

G the spout.

a the air-valve in the piston.

H the air-vessel.

I the ajutage-pipe.

K a colander, which is necessary when the water is mixed with any extraneous matter, to prevent the ajutage-pipe from being choked.

b a screw for securing down the air-valve, when the piston is wanted air-tight in descending.

Fig. 2 is a plan of the pump, wherein the same parts are marked by the same letters as in Fig. 1.

The

The dotted lines in Fig. 2 represent a plan of the suction-piece.

Figs. 3 and 4 are a front view and section of the stopple commonly used for plugging up the spout, when the water is to be discharged by the ajutage-pipe. This stopple is covered on the edge with leather, or some soft material, and is made with a bevel inwards, so that, when admitted by its oval form within the cistern, it presents its less surface outwards, and is pressed tight by the water in the cistern.

N. B. These drawings represent the pump as it was made of metal, with every part executed in the manner that was most convenient; and they give so clear an idea of the construction of the pump, as to render any farther description in words unnecessary.

Fig. 1.

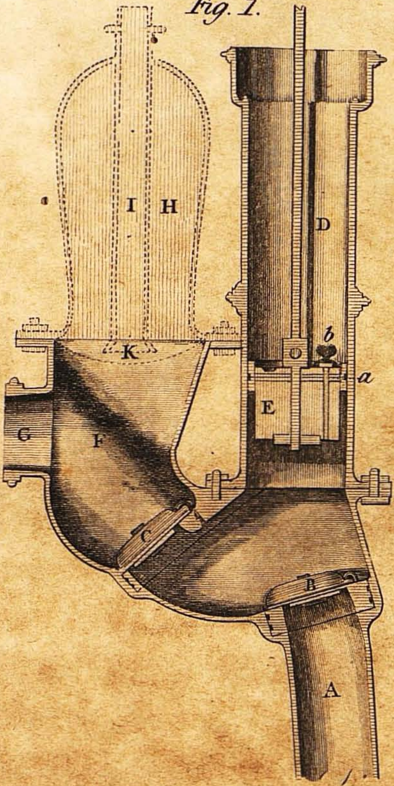


Fig. 2.

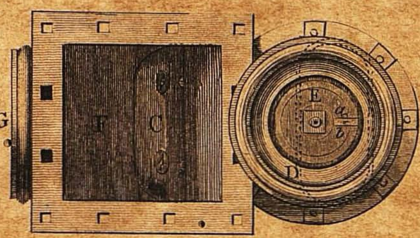


Fig. 3.

Fig. 4.

XXIX. *Specification of the Patent granted to Mr.* RICHARD DEARMAN, *of Birmingham, in the County of Warwick, Ironmaſter; for making Mills for grinding Malt, and various other Articles, in the ſame Manner thoſe Articles are ground in what are commonly called Steel-Mills.*

Dated March 22, 1779.—Term expired.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE that, in compliance with the ſaid proviſo, I the ſaid Richard Dearman do hereby declare, that my ſaid invention of an intire new method of making mills for grinding malt, wheat, barley, beans, peaſe, groats, rice, Indian corn, coffee, pepper, ſeeds, drugs, and all kinds of ſpice, in the ſame manner thoſe articles are ground in what are commonly called ſteel-mills, is deſcribed in the manner following; that is to ſay, to form the grinding-parts of the mills,

or

or what is called the inside and outside thereof, melt iron in a furnace or crucible, and cast the same in moulds of a suitable shape and size for the different purposes for which they may be intended. Then, to soften them, in order to file the teeth to a proper edge, neal them in a gradual heat until that be effected; afterwards harden the grinding-parts of the mill with hoofs, horns, or bones of animals, or charcoal pounded or ground small, or common soot mixed with kelp, or common or marine salt laid on with grounds or lees of malt-liquor, or other acid or glutinous matter. Heat them in a furnace, muffle, or open fire, and plunge them in water. In witness whereof, &c.

XXX.

XXX. *Description of a Method of preventing Injury to the Health of the Workmen employed in preparing White Lead. By Mr.* ARCHER WARD, *of Derby White-Lead Works.*

WITH A PLATE.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Gold Medal of the Society was voted to Mr. WARD for this Invention.

IN order to explain, as well as I can, the advantage that will accrue to the workmen by adopting my invention, in preference to the common mode of preparing white lead, I will first state what the common mode is. When blue lead is in part corroded in the stacks, by an acid raised by a considerable degree of heat, brought on by horse-litter, the corroded and

uncorroded lead are taken from the ſtacks to a room called the engine-loft, where a pair of iron rollers is fixed with a ſcreen under them. The lead in this ſtate is paſſed through the rollers and ſcreen; from the motion of theſe rollers and ſcreen, by which the white lead is ſeparated from the uncorroded or blue lead, together with the moving the lead in order to its being paſſed through them, a very conſiderable quantity of fine duſty white lead is raiſed, which almoſt covers the workmen thus employed, and is very pernicious to them. And not only in this part of the proceſs are they liable to be thus injured, but they are again expoſed to the duſty lead, by removing the blue lead from the ſcreen-houſe to the furnace, as there ſtill remains a quantity of the fine particles of white lead, which of courſe riſes in removing it; and alſo, in removing the white lead from under the ſcreen to the grinding-tub, a quantity of the duſt ariſes, which is very detrimental to the people ſo employed.

My invention removes all theſe difficulties reſpecting the dry duſty white lead, ſo very injuri-

ous to the health of the working people; and consists of a vessel, as shewn in Plate XV, Fig. 1, twelve feet long, six feet wide, and three feet ten inches deep. In this vessel is fixed a pair of brass rollers in a frame, one roller above the other. The centre of the rollers is about ten inches below the top of the vessel; and, one inch lower, is a covering of oak boards or riddles, an inch thick, fixed in the inside of the vessel, in a groove, so as to be taken out occasionally: these boards are bored, with a centre-bit, as full of holes as may be, without danger of breaking into each other; the size of these holes is, in the machine at large, about five-eighths of an inch diameter. This being done, the vessel is filled with water, about three inches above the oak boards or riddles; the lower brass roller is now under water, and about half of the upper roller is under water also. Thus the lead coming from the stacks is put through the brass rollers in water, and, by raking the lead with a copper rake over the oak boards or riddles, the white lead passes through the riddles, and the blue lead remains above; which, being taken out,

is thrown upon an inclined plane of ſtrong laths to drain, where it remains about twelve hours, when the blue lead is ready for the furnace to be remelted; by this means no duſty white lead can riſe in any part to the work-people. No ſuch plan as this (although long deſired) has, to my knowledge, been put in execution, ſo as to anſwer all the purpoſes above ſtated. It may be aſked, why the lead in the common mode is not made wet before it is paſſed through the rollers and ſcreen. Should this be done, the lead would be a paſte on the rollers and ſcreen, and the white lead prevented ſeparating from the blue lead, which is abſolutely neceſſary in the preparation of white lead.

Explanation of the Figures.

(See Plate XV.)

Fig. 1, A, an inclined plane of wood, on which the white and blue lead is placed immediately from the ſtacks, and thus introduced between the braſs rollers B B.

C C, the veſſel containing water.

DDD,

DDD, the pierced oak boards or riddles, which, by being made to slide in grooves in the sides of the vessel CC, may occasionally be taken out by removing the wooden bar *e e*.

E, a handle or winch, which, in the machine at large, may be a wheel communicating to mill-work, and thus turn the rollers BB.

F, a pinion, fixed on the gudgeon of the upper roller, and communicating with a similar pinion on the arbor of the lower roller, keeping both of them in motion by the turn of the handle. As it is necessary that the upper roller should be at liberty to rise or fall, in order to give a due degree of pressure to the lead in passing between the rollers, two weights GG, with proper stems to them, (as shewn more at large in Fig. 2,) are placed over the gudgeons of the upper roller, thereby keeping a due degree of pressure; and, if any piece of the lead should be thicker than usual, admitting the roller to give way to it, and thereby preventing any injury to the machinery.

H, a notch in one side of the wooden vessel, serving to regulate the depth of the water on the riddles DDD.

The

The foregoing deſcription is accompanied by two certificates; one from Mr. Samuel Walker Parker, ſtating that many tons of white lead have been made, in the manner above deſcribed, at the manufactory at Iſlington belonging to Walker, Ward, and Co. and that, ſince Mr. Ward's plan was adopted, no other method has been uſed. The other certificate is from Mr. H. Browne, of Irongate, Derby; who ſays that he thinks the foregoing invention a very valuable improvement in preparing white lead, and that the quality of the lead is not in the leaſt injured by it.

Fig. 1.

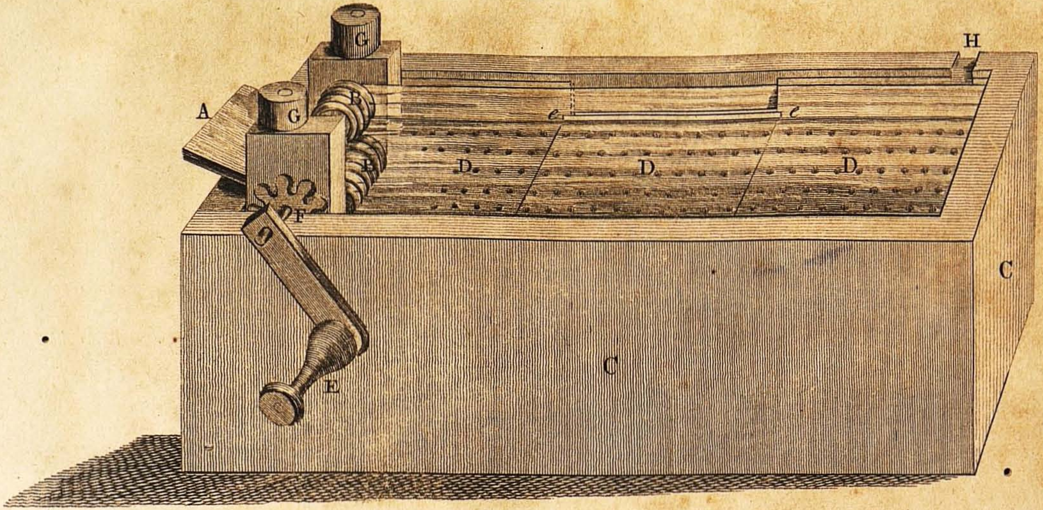
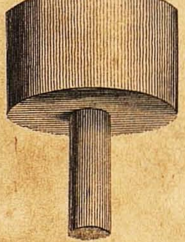


Fig. 2.



XXXI. *Experiments on the alkaline Subſtances uſed in bleaching, and on the Colouring-Matter of Linen-Yarn.* By RICHARD KIRWAN, *Eſq. F. R. S. and M. R. I. A.*

From the TRANSACTIONS of the ROYAL IRISH ACADEMY.

SECTION I.

BLEACHING being one of thoſe arts which conſiſt in ſcarce any thing elſe than a particular application of ſome of the general principles of chymiſtry, it might be expected that the knowledge of the inſtruments it employs would keep pace with the progreſs and improvements of that ſcience to which it is ſubordinate, and ſo much the more as the nature of alkaline ſubſtances in general, which are its proper inſtruments, has been in great meaſure explained by the celebrated Doctor Black upwards of thirty years ago;

yet

yet it has ſo happened that, on a late occaſion, when a ſcarcity of theſe ſaline ſubſtances, imported from foreign countries, unhappily prevailed in this kingdom, it was ſeriouſly queſtioned whether their place could be ſupplied by materials manufactured at home. In the courſe of this diſcuſſion it evidently appeared, from the contradictory teſtimonies of many of the principal bleachers, that, however they might excel in that art, when well provided with the inſtruments they employ, they were but little acquainted with the general agency of the inſtruments themſelves, and their reſpective powers, or even with the moſt advantageous and œconomical method of employing them. To elucidate theſe points, by an analyſis of ſome of the different ſubſtances employed by bleachers, and by giving a ſure method of diſtinguiſhing the relative powers of every ſaline ſubſtance they may uſe, together with an account of the beſt method of obtaining them, as well as of adapting them to the purpoſe of bleaching, is the object of this paper. This taſk, which I have impoſed upon myſelf ſolely with a view to the

utility

utility of the public, requires no ingenuity, and might have been long ago well executed by many others, if chymiſtry, which has ſo many votaries of the higheſt rank in the moſt civilized parts of Europe, had been more known and cultivated in this country, which perhaps of all others ſtands moſt in need of its aſſiſtance.

SECTION II.

Barilha. Of this ſubſtance there are ſeveral ſorts, made of different plants *, but the beſt is that formed near Alicant, at a diſtance from the ſea, by the combuſtion of a plant called by the inhabitants *barilha*, and deſcribed by Juſſieu, in the Memoirs of the Academy of Paris for 1717, under the name of *Kali Hiſpanicum ſupinum annuum, ſedi foliis brevibus*. It is called by Linnæus *Salſola ſativa*, and ſhould carefully be diſtinguiſhed from the various ſpecies of *Salicornia*, and of *Chænopo-*

* See Colonel Conyngham's letter: report of the committee of the houſe of Commons in Ireland, 1788, p. 87.

dium, which yield an alkali, but leſs pure than the *Salſola*. Theſe plants, being dried to the ſame degree as hay, are burned in pits, nearly as kelp is with us; the aſhes and ſalt run into a greyiſh blue maſs, which is the barilha *. The beſt ſort is here called *ſweet barilha*.

The ſweet barilha which I examined was preſented to me by Mr. Byrne, an eminent merchant of this city. It was of a bluiſh colour, covered over with a ſaline powder, exceedingly hard, and had a ſmart alkaline taſte. When broken, it looked black in the fractured part, and viſibly contained pretty large pieces of charcoal.

To find the proportion of fixed air in this ſubſtance, having reduced a quantity of it to fine powder, I poured on an ounce of it a ſufficient quantity of marine acid, and found it to loſe, by the action of this acid, 80 grains of its weight; conſequently one pound troy of this ſubſtance contains 960 grains of fixed air, (mixed with a

* It is called by the French *ſoude*, being employed in ſoldering metals.

little

little that had an hepatic ſmell,) that is, exactly $\frac{1}{6}$ of its weight. Other parcels contained ſomewhat more, and others ſomewhat leſs.

As this ſubſtance evidently contained ſome parts that were ſoluble in water, and ſome that were inſoluble therein, to diſcover the weight of each, I poured on one pound of it, reduced to fine powder, thirteen pounds of water moderately hot, ſucceſſively; this water had previouſly been boiled and filtered, and contained no other impurity than a ſlight trace of common ſalt. This quantity of water was neceſſary to exhauſt all the ſoluble matter in the barilha.

The ſolutions were taken in ſix different portions; none of them betrayed the ſmalleſt mark of ſulphur, of which I was aſſured, by trying them with the nitrous ſolution of ſilver; nor did the Pruſſian alkali diſcover any veſtige of iron.

By eighteen ſucceſſive evaporations and cryſtalizations, I obtained 4881 grains of ſaline matter, the different ſpecies of which I ſhall preſently mention, and 2903 of inſoluble matter.

It may at firſt ſight appear extraordinary, that the ſaline matter and the inſoluble part ſhould weigh more than the pound of barilha that ſeemed to afford them; for, this amounts only to 5760 grains, and the two former weighed 7784 grains; but, it ſhould be conſidered that theſe products were obtained, not from the barilha alone, but from the barilha and the water in which the ſalts were diſſolved, whoſe cryſtals retained a great quantity of it; and alſo from the air to which the ſolutions were expoſed, and which they abſorbed in large proportion.

As the quantity of the inſoluble matter was ſubject to no ſuch deceptive appearance, I began by examining the weight of that; for this, being ſubtracted from 5760 grains, neceſſarily determined the true weight of the ſaline part; and, as the ſtate in which the ſaline part exiſts in barilha depends, in ſome meaſure, on the earths and charcoal with which it is united, as well as the moſt advantageous method of uſing it, I examined the nature and quantity of theſe very minutely.

Having therefore dried the insoluble matter for a considerable time in a low heat, until it appeared as dry as the barilha itself, and having found its weight in that state to amount to 2903 grains, or 6,04791 ounces, I took one ounce of it, and, drying it in a heat little below redness found it to lose 38 grains of moisture.

Another ounce of the same residuum, being treated with dilute marine acid, lost 125,5 grains of its weight, and this loss expresses the quantity of fixed air contained in it.

Another ounce, being calcined in a white heat for about one hour, lost 200 grains of its weight; on repeating this experiment, I found the loss amount to 199 grains.

Lastly, on the 281 grains, which remained after this experiment, I poured dilute marine acid, and found the quantity of fixed air to be 106 grains.

Hence I deduce the weights of the several substances dissipated by the calcination of an ounce of the insoluble residuum of the barilha:

First. The weight of the fixed air lost was 125,5 —106=18,5 grains.

Secondly. The loſs of moiſture was 38 grains.

Thirdly. The loſs of the fixed air and moiſture amounted together to 56,5 grains. This, deducted from the entire loſs, that is from 199 grains, gives the loſs ariſing from the combuſtion of the charcoal, and conſequently its quantity, 199—56,5=142,5 grains.

I next proceeded to examine the fixed incombuſtible part that remained after the above calcination. On 279 grains of this, which remained after the calcination of an ounce of the inſoluble part, I poured a quantity of diſtilled vinegar, whoſe ſpecific gravity, in the temperature of 62°, was 1,008, and digeſted that reſiduum therein for ſixteen hours, in a heat little more than 100°. After edulcoration and deſiccation, I found the weight of what remained undiſſolved to amount to 63 grains. Upon this experiment I reaſoned thus: 281 grains of a reſiduum of this ſort contained 106 grains of fixed air, therefore the 279 grains ſubjected to the vinegar in this experiment muſt have contained 105,24, which were diſſipated by the action of the acid; there

there remained therefore of mere earth only 173,76; but, of these, 63 escaped the action of the acid, therefore there were dissolved 110,76; and, as distilled vinegar can act only on calcareous and muriatic earth, (the barytic being not expected,) the 110,76 that were dissolved must have consisted of either or both of these, and the undissolved 63 grains must have been argillaceous, or siliceous.

To determine the first point, I distilled, in a glass retort, the acetous solution, which was very voluminous, until no more than about four pints remained. During the distillation some earth was deposited, which, when dried in a red heat, amounted to 4 grains; this I re-dissolved, and, finding it precipitable by caustic volatile alkali, judged it to be magnesia. I then took as much of the acetous solution as amounted to $\frac{1}{6}$ of the whole, and, pouring caustic volatile alkali upon it, obtained nearly 3 grains, or more exactly 2,83 grains, of magnesia precipitated by the alkali. Whence I concluded the whole solution to contain 17 grains, to which adding the 4 grains deposited,

posited, we have the entire quantity of magnesia dissolved by the vinegar = 21 grains, and consequently the remainder of 110,76 grains, namely, 89,76, must have been calcareous earth.

I also examined the quantity of this earth in another manner: to the $\frac{5}{6}$ of the acetous solution that remained, I added gradually vitriolic acid, whose specific gravity was 1,463, as long as any precipitation appeared to take place; then, pouring off the vinegar, I edulcorated the residuum, and, having dried it, found it to weigh 240 grains, and consequently, if the whole acetous solution had been used, the resulting selenite would have weighed 288 grains; now 100 grains of selenite contain 32 of calcareous earth, therefore 288 grains contain 92,16 grains, which differs inconsiderably from the former determination.

Lastly. The 63 grains which eluded the action of the acetous acid, being digested in spirit of salt, left a residuum of 41,3 grains, which therefore was siliceous; the remainder, not being precipitable by the vitriolic acid, was consequently argillaceous earth; hence the quantities of

of theſe ingredients in 480 grains of the inſoluble part of barilha were found to be,

	Grains.	And in the whole inſoluble part, Grains.
Fixed air, - -	125,5	759
Water, - -	38	229,82
Charcoal, - -	142,5	861,82
Calcareous earth, -	89,76	542,86
Muriatic ditto, (magneſia,)	21	127
Argillaceous ditto, -	21,7	131,23
Siliceous ditto, -	41,3	249,58
	479,76	2901,31
Error -	,24	Error - 1,69
	480,00	2903,00

I now return to the ſoluble part of the barilha, which neceſſarily amounted only to 2857 grains, as 5760—2903=2857.

In the firſt place, I obtained 4213 grains of pure cryſtalized mineral alkali, but theſe cryſtals are known to contain but $\frac{1}{5}$ of real alkaline ſubſtance,

the remainder of their weight being fixed air, and water of cryſtalization; therefore one pound of barilha contains but 842 grains of pure real alkali.

Beſides this, I alſo obtained 127 grains of a mixture of mineral alkali and common ſalt, which I could not eaſily ſeparate: and 346 grains of a mixture of vegetable and mineral alkali, with a ſmall proportion of extractive matter, and ſome digeſtive ſalt, as I believe: this maſs conſtantly attracted moiſture. I weighed it hot and dry, but forgot to examine the portion of fixed air it contained; it could not be leſs, nor much more, than 28 *per cent.* and therefore this maſs contained about 250 grains of mere alkali.

Theſe ſolutions, and particularly the laſt portions, afforded alſo 125 grains of Glauber's ſalt, and 70 of common ſalt; but the Glauber's ſalt at leaſt did not exiſt in a cryſtalized form in the barilha; and, as 100 grains of it are reduced to 42, by expelling the water of cryſtalization, no more than 58 grains of it can be deemed to have preexiſted in the barilha.

Theſe

These solutions also deposited 20 grains of earth.

Hence the weights of the different ingredients contained in one pound of sweet barilha are as follow:

Fixed air, - -	960	
Charcoal, - -	861,82	
Calcareous earth, -	542,86	1050,67
Muriatic ditto, - -	127	
Argillaceous ditto, -	131,23	
Siliceous ditto, - -	249,58	
Mineral alkali, pure, -	842	1219
Ditto, impure, - -	250	
Ditto, mixed with common salt, - - -	127	
Glauber's salt, - -	125	
Common salt, - -	70	
Earth deposited, -	20	
	4306,49	
Water, - -	1453,51	
Total, -	5760,00	

Hence we ſee, that the alkaline part of barilha is nearly in a cauſtic ſtate; for, the entire pound of barilha contained but 960 grains of fixed air, and, of this quantity, we have ſeen that 759 were contained in the earthy part; therefore only 201 grains were contained in the ſaline part. Now 960 grains of this (and the mere alkaline part did not certainly amount to leſs) require for their ſaturation at leaſt 700 of fixed air, therefore they wanted at leaſt $\frac{2}{3}$ of the quantity requiſite to ſaturate them. Hence bleachers ſhould not uſe boiling water to extract the ſaline ſubſtance of barilha; for the alkaline part, being in a cauſtic ſtate, diſſolves part of the coaly matter with which it is united, which ſullies the ſolution, gives it a dark hue, and afterwards is depoſited on the linen, and cannot be ſeparated by acids.

SECTION III.

Of Dantzic pearl-aſh. This ſalt was alſo ſent to me by Mr. Byrne. It is exceeding white, and, if not expoſed to the air, very hard, and poſſeſſes an alkaline taſte.

The

The quantity of fixed air and earth contained in different parcels of this ſubſtance is variable; in ſome ounces I found the quantity of fixed air to amount to 100 grains, in others to 115; and therefore, at a medium, it may be rated at 107,5 grains, or 1290 grains in one pound Troy. The earth remaining after the ſolution of one pound amounted to 20 grains.

One ounce of this ſubſtance, gradually heated to redneſs, and kept in that heat for three quarters of an hour, loſt 70 grains of its weight; and, being then diſſolved in ſpirit of ſalt, loſt 72 grains; therefore the quantity of moiſture in one ounce of this ſubſtance was $70 - \overline{107,5 - 72} = 34,5$ grains, or 414 in one pound.

Again, after ten evaporations, I procured from one pound of this ſubſtance 505 grains of vitriolated tartar, the laſt portions of which appeared, by the teſt of the nitrous ſolution of ſilver, to contain ſome digeſtive ſalt; and alſo 36 grains of this laſt, containing a portion of vitriolated tartar: about 38 grains of earth were depoſited during the evaporations. The remainder of the pound, after all theſe deductions, muſt have con-

6 ſiſted

fiſted of mere alkali. Hence the ingredients in a pound muſt have been nearly in the following quantities:

Fixed air, - -	1290	
Moiſture, - -	414	
Vitriolated tartar, -	505	
Digeſtive ſalt and ditto,	36	
Earth, - - -	38	
	2283	5760
Mere alkali, -	3477	2283
	5760	3477

Diſguſted by the tedioufneſs of theſe experiments, and recollecting that the alkaline part of theſe ſalts was that alone with which bleachers had any concern, I bethought myſelf of an eaſy practical method of diſcovering the preſence of this principle, and determining its quantity in all ſubſtances in which it exiſts, either uncombined, or combined only with fixed air, or ſulphur.

TO BE CONTINUED IN OUR NEXT.

XXXII.

XXXII. *Conclusion of M. de* Puymaurin's *Memoir on the Action of the Fluor-acid upon siliceous Earth, &c.*

(FROM P. 216.)

THE iron-filings in the first phial were partly dissolved, and the solution furnished vitriol of iron: in the second phial, the liquor was only covered with a ferruginous crust, of a reddish colour. The two phials were then exposed to a strong heat, and the fluor-acid was volatilized in the form of a vapour, which was sharp and penetrating. The residuum of the first phial retained a styptic taste, while that of the second had the colour of *crocus martis*, and was insipid to the taste.

The same thing was found to take place with respect to calx of copper, precipitated from blue vitriol by fixed alkali, and also with respect

to

to lead, and tin, when theſe ſubſtances were expoſed to the action of the two different kinds of fluor-acid.

I put a ſmall piece of a diamond into the fluor-acid, in a glaſs veſſel, and heated the veſſel two or three times in a ſand-heat; after the diamond had been four or five days in the acid it diſappeared, and nothing could be obſerved in its place but ſome ſmall ſhining particles, which rolled about at the bottom of the veſſel, if it was at all agitated. This experiment appeared to me ſo ſingular, that I thought it right to repeat it upon two other diamonds: theſe two did not appear to ſuffer the ſmalleſt alteration. I know not what was the cauſe of the diſſolution, or rather of the extreme diviſion, of the firſt diamond; but, if I had not repeated my experiment, I ſhould have ſuppoſed that the fluor-acid was a menſtruum for diamonds, as well as for glaſs. I expoſed various gems, and other ſiliceous ſubſtances, to the action of this acid; but, as ſuch an enquiry demands numerous experiments and obſervations, conducted with great care and aſſiduity, in order

to

to be able to depend upon the results, I shall relate only some detached experiments, until the action of the fluor-acid upon gems and stones shall be determined with accuracy. It is by no means indifferent in what vessels the pieces of stone or gems to be examined are placed. The glass vessels I at first made use of were not so proper for the purpose as I wished. The great affinity of the acid with the quartzose earth of such vessels prevents its action upon the substances put into it. The internal surface of the vessels is corroded; a grey gelatinous substance covers the pieces of stone, &c. and they are little or not at all acted upon by the acid.

Vessels of box wood, although varnished, could not resist the gentle heat necessary to hasten the action of the acid; which soon penetrated through their pores, in such a manner that it was necessary to procure vessels of another kind.

Vessels of tin had all the advantages I wished; but we must apply heat very gradually, because the acid becomes volatile with a very gentle heat, and the vessels, when empty, are apt to melt.

It is alſo neceſſary to be very particular reſpecting the purity of the fluor-acid; if it is mixed with ſulphuric acid, this laſt attacks and calcines the metal of the veſſels, and the fluor-acid then exerts its action upon theſe calces or oxides, and becomes loaded with them.

If we ſhould be able, as I hope we ſhall, to analyſe gems and other ſtony ſubſtances in a new way, by means of the fluor-acid, we muſt always deduct from the products the Pruſſian blue or pruſſiate of iron, which the fluor-acid always contains, and alſo the calx or oxide of tin, or of lead, which it may have taken up during the diſtillation.

I expoſed the following ſubſtances in tin veſſels, with a ſufficient quantity of fluor-acid to cover them, to a moderate heat, for the ſpace of two days.

A cryſ-

	Weighing.	Weighed after the operation.	Loſs of weight.
A cryſtal of Brazilian topaz,	24 grains	22 grains	2 grains
A topaz cut, -	2	2	0
An amethyſt, -	3	3	0
An opal, -	4	$2\frac{1}{2}$	$1\frac{1}{2}$
The kind of jaſper called blood-ſtone, -	$8\frac{1}{2}$	7	$1\frac{1}{2}$
Red jaſper, -	$5\frac{1}{2}$	$4\frac{1}{2}$	1
Striped agate,	6	5	1
True aventurine, but of inferior quality, -	$4\frac{1}{2}$	3	$1\frac{1}{2}$
Coarſe agate, uſed for gun-flints,	7	$5\frac{1}{2}$	$1\frac{1}{2}$
Two pieces of feld-ſpar,	18	$12\frac{1}{2}$	$5\frac{1}{2}$
Hyacinth, -	$6\frac{1}{2}$	$5\frac{1}{2}$	1
Peruvian emerald,	12	10	2
Green ſchorl,	8	$7\frac{1}{2}$	$0\frac{1}{2}$
Rock cryſtal *,	$3\frac{1}{2}$	$3\frac{1}{2}$	0

* This cryſtal loſt its poliſh in the acid.

The Brazilian topaz, the Emerald, and the Hyacinth, did not lofe their polifh, and their angles only feemed to have been attacked.

The opal loft its polifh and water; its furface became rough, fo that it appeared like a clouded opaque cryftal. The ftriped agate loft its tranf-parency, and its fine red colour. The aventurine appeared only like a piece of a grey pebble, and its brilliant particles had entirely difappeared. The blood-ftone fuffered the greateft change; the beautiful broad red fpots, from which it takes its name, were changed into fpots of a brownifh red colour; the dark green was changed into a grey-afh colour; and the hardnefs of the ftone was fo diminifhed that it might be fcraped with a knife. It had alfo become very brittle; when broke, the broken part appeared of a dark brownifh green colour *.

The feld-fpar had evidently been acted upon; it appeared to be covered with a white powder, but ftill preferved its tranfparency.

* Since thefe experiments were made, I have engraved various characters upon blood-ftone, and upon agate, by means of the fluor-acid.

Green

Green schorl, tourmalin, and black schorl, seem to be very little affected by this acid.

A small hexaedral crystal lost its polish, but did not decrease in weight. A piece of phosphoric glass, of the most complete transparency, suffered no loss, either of polish or weight.

Four small garnets lost a portion of their weight, and became of a beautiful dark rose-colour; their outer surface having been taken off by the acid.

The zeolite of Feroe was dissolved by the fluor-acid, and formed a jelly with it, as with other acids.

The blue lava of Mount Vesuvius, which has the appearance of lapis lazuli, and of which snuff-boxes are made at Naples, was dissolved with effervescence; the residuum was a black spongy mass.

The silky asbestos of Corsica lost its suppleness, and became hard and brittle.

Black mica lost its brilliancy and its elasticity; being dried, it acquired a dark grey colour, and became very brittle. Gypsum from Montmartre, and

and ſand-ſtone from Fontainebleau, were completely diſſolved.

It may be obſerved, from the experiments above deſcribed, that the fluor-acid acts moſt readily upon ſiliceous ſtones; but I believe that its action is increaſed by their being of a mixed nature, becauſe the ſiliceous earth is then more minutely divided: for that reaſon it acts more readily upon glaſs than upon rock-cryſtal. The ſiliceous earth in glaſs is divided by fuſion, and by its mixture with alkaline ſubſtances; and conſequently preſents a multitude of ſurfaces to the action of the acid, which ſoon deſtroys it; reducing it into a light powder, of a ſhining white colour, and which may be again fuſed by being mixed with an alkali.

This effect of the fluor-acid was at firſt denied, but the corroſion of the glaſs of retorts put the matter out of doubt. Macquer conſidered this as the effect of the fluor-acid in the gaſeous or aeriform ſtate. I ſaw in M. Fourcroy's laboratory a piece of glaſs, which had loſt its poliſh, and was corroded, by the gas which exhaled from a retort in which was left the reſiduum of a diſtil-

lation

lation of fluor-acid. Being surprised at this singular and expeditious effect of that acid, I thought it right to try whether I could not produce a similar effect by means of the fluor-acid combined with water. My experiments succeeded, and I convinced myself that the fluor-acid had almost as much action upon glass as aqua fortis and other acids have upon copper, or other metals.

I had now only to go one step farther, in order to make some advantage of this property of the fluor-acid, and to render it useful to the arts. Imitating the process of engravers upon copper with aquá fortis, I covered a piece of glass with a coat of wax, and, having drawn some figures upon it, I applied flour-acid over the whole, and exposed it to the sun. I observed soon afterwards that the lines which I had drawn were covered with a white powder, arising from the dissolution of the glass. After four or five hours I took off the coat of wax, and cleaned the glass. I then found, with the greatest satisfaction, that my conjectures were true, and I was thereby assured that a skilful en-

graver

graver might, by means of the fluor-acid, engrave upon the hardeſt glaſs, in the ſame manner as he can engrave upon copper with aqua fortis.

But though the reſult of my firſt trial was ſuch as to encourage me to proceed, I could not help remarking that the lines of the engraved figure were of unequal thickneſs, and full of irregularities. As I was ignorant even of the firſt principles of engraving, I could not hope to be able to bring this diſcovery to perfection; but I thought it right that I ſhould endeavour to remove thoſe cauſes to which the inferiority of my work was owing.

The coat of wax had been laid on too thick, which had prevented me from giving to the outlines of my drawing the delicacy they ought to have had; and the action of the fluor-acid had rendered them thicker in thoſe parts where the coating was not evenly laid on.

I ſoon found that it would be neceſſary to make uſe of a varniſh which ſhould be ſufficiently thin to admit of ſhading, and performing other delicate parts of engraving; and at the ſame time ſo

ſtrong

ſtrong that, when applied evenly upon the glaſs, it ſhould not be taken off, or deſtroyed, by the action of the acid.

The difficulty of applying a ſubſtance of that kind upon the ſurface of glaſs, makes this part of the operation very troubleſome. The ſtrong varniſh uſed by engravers was found to anſwer pretty well, but the ſmalleſt negligence in applying it renders it apt to ſcale, and to be penetrated by the acid. The glaſs then becomes dull, the lines are rough, and conſequently the engraving is imperfect. I think therefore that, to bring engraving upon glaſs to its higheſt perfection, it will be neceſſary to diſcover a new kind of varniſh, which ſhall have the properties requiſite for the purpoſe. I tried, with tolerable ſucceſs, the ſtrong varniſh of the engravers, deſcribed in the *Encyclopédie*, and which is compoſed of equal quantities of drying oil and maſtic in tears *. But it

* Being of opinion that oils acquire their drying quality merely from their acidification by the oxygene of the metallic calces with which they are boiled, and red precipitate appearing to me the moſt covenient calx for trying the truth of

it is very difficult to apply it evenly; and it is very long in drying, eſpecially in winter, as it requires to be expoſed to a pretty ſtrong heat, in order to deprive it of its pitchy quality.

I ſhall not give a tedious account of all the trials I made, but ſhall only mention thoſe which appeared to me moſt uſeful.

Before the varniſh is applied, the glaſs muſt be thoroughly cleaned, and heated until the hand can hardly be borne upon it. The varniſh is then to be applied lightly over the glaſs, and laid ſmooth by dabbing it with ſmall balls of ſilk ſtuffed with cotton. It is then to be expoſed to

of my conjecture, I put into a retort two ounces of that ſubſtance, with a certain quantity of common linſeed-oil. I adapted a pneumatic apparatus to the retort, and applied heat to it. Some bubbles of fixed air ſoon paſſed over; upon the fire being increaſed, the air was diſengaged with ſo much rapidity, and ſuch a noiſe was heard in the retort, that, fearing it would burſt, I thought it beſt to unlute it, and to let it cool gradually. I found the next morning, that the mercury was revived, and lay, in the form of ſmall globules, at the bottom of the retort. The oil had acquired a fine red colour, had a very diſagreeable ſmell, and was become very drying. I uſed this oil in making my varniſh.

the

the smoke of small wax-candles, as is done by the engravers with respect to copper-plates, when they make use of aqua fortis.

When the varnish is very dry, and its surface very even, the figure intended to be engraved is to be traced in it. But, the dark colour of the glass not shewing the lines, as copper does, the engraver cannot see what he does, unless he holds the glass up to the light. As this situation would necessarily render his work difficult and troublesome, I have contrived a table, the upper part of which may be raised in form of a desk, and consequently make the task of the engraver more easy. In the middle of this table a pane of glass is fitted; upon it the engraver places the varnished glass on which the engraving is to be made. This glass having light thus thrown upon it, the lines made by the engraver's tool become visible, and consequently he can not only work with greater ease, but can judge of the effects his work will produce.

Artists alone can give to this invention the extent and perfection which it is capable of recei-

ving. But it may not be amiſs to inform them of the precautions which are neceſſary, to prevent their loſing, in an inſtant, the fruits of a tedious and tireſome operation.

It is neceſſary, Firſt, to be well acquainted with the quality of the glaſs made uſe of. Secondly, to aſcertain the ſtrength and purity of the fluor-acid. Thirdly, to attend to the temperature of the atmoſphere.

Bohemian glaſs is not of an equal quality in all its parts; the ſubſtances of which it is compoſed have not undergone a ſufficient fuſion to be well mixed. The fluor-acid acts upon it unequally; the lines engraved upon it are rough, and have not a good appearance, except when viewed on that ſide of the glaſs which is oppoſite to the engraving. Engliſh glaſs, in the compoſition of which a great quantity of calx of lead enters, is eaſily acted upon by the acid; but the leaſt defect in the varniſh lets the acid penetrate; the calx of lead is firſt acted upon, and its ſolution gives a diſagreeable tinge to the glaſs. Plate-glaſs is the ſubſtance which the acid acts beſt upon; the ſiliceous earth is there ſo prepared by the heat it has

ſuffered,

suffered, that the acid meets with it in the state most proper for its action.

That plate-glass which has a white reflection, not a green one, must be chosen. The glass used for small looking-glasses seems to me to merit the preference. The lines of the engravings made upon it are equal in depth, and have no irregularities.

It is necessary to know the degree of purity of the acid made use of. I always use fluor-acid which has been distilled in a leaden retort, according to the method I have already described. That which is distilled in a glass-retort (being mixed with sulphuric acid, and saturated with the siliceous earth of the retort) is less strong, and less equal in its action.

If, when Reaumur's thermometer stands at sixteen degrees in the shade, and the weather is clear and serene, a piece of plate-glass, varnished, traced, and covered with the acid, is exposed to the sun, the engraving is completed in five or six hours; this is known by a white powder, which covers the lines drawn upon the glass. In

winter

winter the glafs is but flightly attacked in four days, and the operation would never be finifhed if the action of the acid were not affifted by a moderate and regulated heat, fuch as that of an oven, or a ftove. The glafs muft not be heated by applying heat under it, becaufe the varnifh thereby becomes foft, and fcales off; the acid confequently penetrates to all parts, and the glafs is made rough, without any regular figure being produced.

We may engrave on glafs either in relief or otherwife. If it is propofed to engrave in relief, the varnifh which covers the ground on which the figures are traced muft be taken off with a fcraper; the fluor-acid muft then be applied, and fpread evenly with a fmall brufh. If the action of the acid is affifted by the heat of the fun, the glafs foon becomes covered with a white pellicle; which is to be taken off, and frefh acid applied, until the ground is thought to be fo much deepened that the figures have a fufficient relief. When it is propofed to take the polifh from certain parts of glafs, the fame operation may be practifed.

To

To engrave in the common way, the glaſs muſt have a border of engravers wax put round it, and, in all other reſpects, we muſt proceed as is uſual in engraving with aqua fortis.

In order to judge of the ſtate of the engraving, a corner of the glaſs muſt be expoſed, and examined. If the operation appear to be finiſhed, the acid is to be poured off, and the ſame acid may ſometimes be employed more than once. The glaſs is to be drained, then waſhed two or three times with clean water, to take away the ſuperabundant acid, and afterwards dried. The varniſh may be taken off with a coarſe cloth, dipped in ſpirit of wine, and the glaſs may be cleaned with chalk finely powdered.

M. Fourcroy, in his Elements of Chemiſtry, ſays that the fluor-acid has not been put to any uſe, but that its property of diſſolving ſiliceous earth will render it very uſeful. I have fulfilled a part of the predictions of this able chemiſt, by applying this acid to engraving upon glaſs. It may eaſily be rendered of ſervice to philoſophy, by employing it for taking the poliſh from plate-

glaſs,

glaſs, and from the inſtruments uſed as eudiometers; alſo for graduating thoſe inſtruments to which hitherto ſcales of box-wood, or of copper, (which are always uncertain,) have been adapted. Perhaps hereafter thick plates of glaſs may be uſed for engraving prints, maps, &c. They may be made thick enough to reſiſt the preſs, and would have the advantage of not being liable to wear; conſequently all the impreſſions would be of equal ſtrength, and the plates might be delivered to poſterity without any danger of their being deſtroyed or even damaged by ruſt.

REPERTORY
OF
ARTS AND MANUFACTURES.

NUMBER XXIX.

Printed by JOHN NICHOLS, Red-Lion-Paſſage, Fleet-Street, London.

XXXIII. *Specification of the Patent granted to Mr.* JOHN PEPPER, *of Newcaſtle under Line, Builder and Architect; for his Invention of a certain Kiln, for the Purpoſe of drying Malt, or other Grain.*

WITH TWO PLATES.

Dated June 9, 1796.

TO all to whom theſe preſents ſhall come, &c. Now KNOW YE that, in compliance with the ſaid proviſo, I the ſaid John Pepper do hereby declare, that the nature of my ſaid invention, and the manner in which the ſame is to be performed,

s defcr ibed and afcertained in the plans hereunto annexed, and the following defcription: that is to fay; Fig. 1 (Plate XVI) is the ground plan, fuppofed to be twenty feet fquare, but, if required larger or fmaller, by following the fame proportion, may be made agreeable to any fize or fituation. The dark-fhaded walls rife four feet high, to put the reflector upon, over the fire, and alfo what the fide-arches ftand upon, the brick piers that carry the fpark-ftone, and bearers that the tiles lie upon. Letter A, firegrate, lies nine inches below the bottom edge of the reflector. B, bottom edge of the reflector. CCCC, brick pillars, nine inches fquare, that carry the fpark-ftone. DDDDDD, brick pillars, nine inches fquare, that carry the bearers for the floor-tiles to lie upon. E fhews the bottom of the fide-arches on each fide of the kiln. F fhews the fpace between the fire-place and the fide-arches, for the man to go round to clean the kiln. G, the wall on each fide the kiln, that the fide-arches ftand upon.

Fig. 2. Section. G fhews the fection of the wall which the fide-arches ftand upon. H, door to go

to

to the fire-place. I, the reflector of caſt iron that covers the fire. K, ſmall door in the reflector, to feed the fire. L L, the ears of the reflector that the iron pipes are fitted upon, which convey the ſmoke &c. from the reflector, round the kiln, to the chimney. M, what is commonly called the ſpark-ſtone; it prevents the kiln from being too hot in the middle, and aſſiſts in ſpreading the heat to the outſides. N, bearers of caſt iron, or wood, that carry the kiln-floor. O O ſhew the ends of the ribs that carry the tiles. P, the kiln-tiles that the malt lies upon. Q, the ſteam-pipe that conveys the ſteam from the malt. C C, brick pillars, nine inches ſquare, that carry the ſpark-ſtone. D D, brick pillars, nine inches ſquare, that carry the bearers for the floor-tiles to lie upon. E E ſhew the arches on each ſide the kiln. U U ſhew the ſituation of the pipes under the floor.

Fig. 3. (Plate XVII.) Plan of the kiln-floor, ſhews the ribs that the kiln-files lie upon. O O the caſt iron or wood-ribs that the tiles lie upon. N N, the bearers that carry the ribs. D D ſhew the

tops of the brick pillars that carry the bearers, &c. B, the reflector that covers the fire, of caſt iron, about an inch thick, hollow, and on a ſemicircular plan, as ſhewn in the drawings. R R, the iron pipes that convey the ſmoke and heat from the reflector, round the kiln, to the chimney, which lies about three feet under the kiln-floor, and about the ſame diſtance from the ſide-walls, which are ſupported by iron ſtays from the ſide-arches. S S ſhew the ends of the iron pipes that go into the chimney. T T, regiſters to regulate the draught and heat.

N. B. The pillars, bearers, &c. that belong to the ſame thing, are marked with the ſame letters in all the figures. In witneſs whereof, &c.

XXXIV.

Fig. 1 Ground Plan.

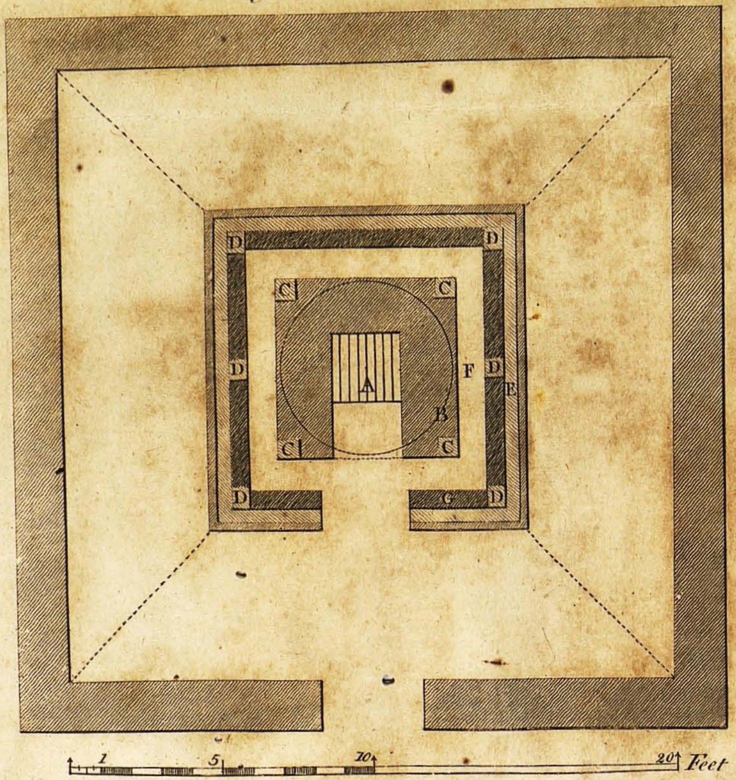
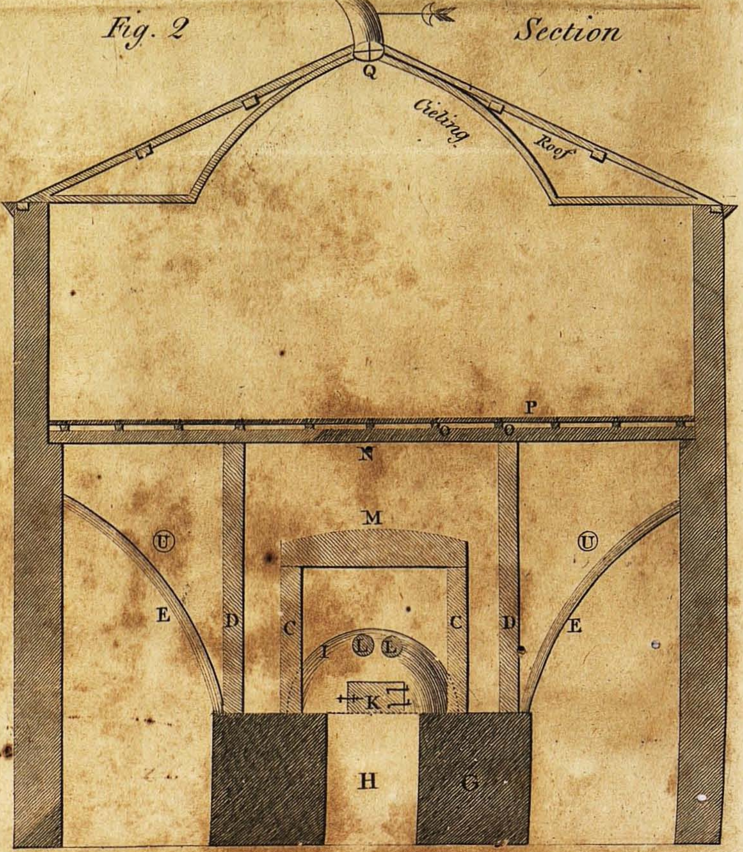
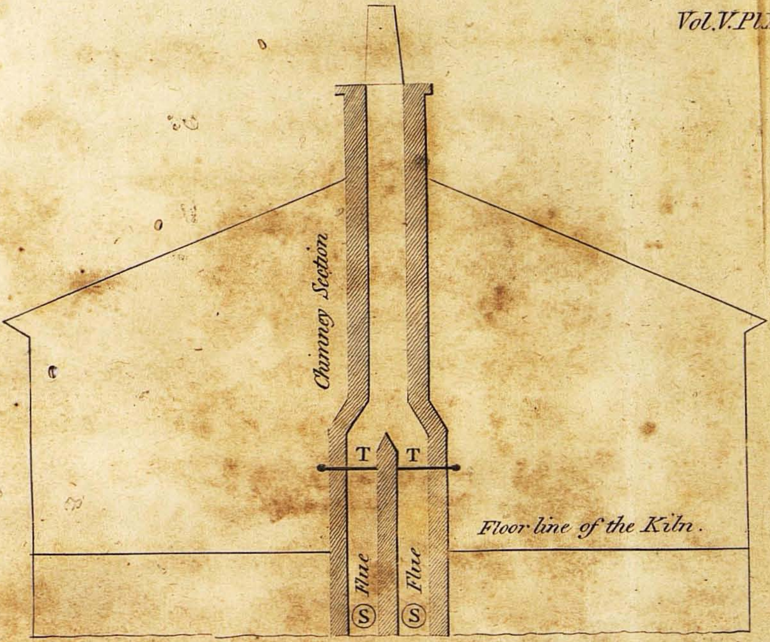


Fig. 2 Section





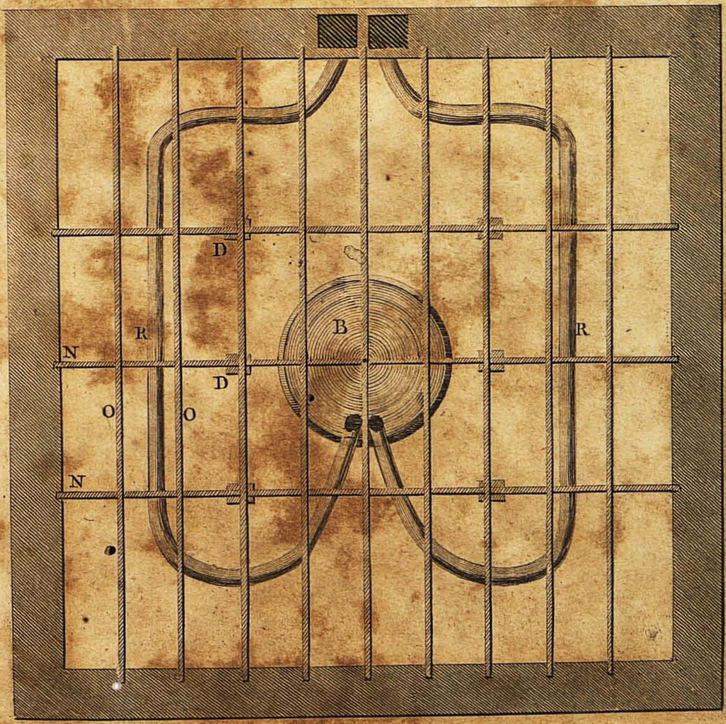


Fig. 3. Plan of the Kiln Floor.

XXXIV. *Specification of the Patent granted to* SAMUEL BENTHAM *of Dover-ſtreet, in the County of Middleſex, Eſq.; for his Invention of a new Method of planing Wood.*

Dated Nov. 26, 1791.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE that, in compliance with the ſaid proviſo, I the ſaid Samuel Bentham do hereby declare, that my ſaid invention is deſcribed in manner following: that is to ſay; the eſſence of the preſent invention, reſpecting the planing of wood, conſiſts in the having diveſted that operation of the quantity of ſkill and attention at preſent neceſſary, in ſuch ſort that brute force may be employed in it; by brute force I mean not only the ſtrength of animals, but the force of inanimate agents, ſuch as wind, water, ſteam, &c. and even that of men, when employed in ſuch a way as requires nothing of ſkill or dexterity on the part of

the perſon who exerts it; by this means, machinery may take place of human ſkill in this operation, to as perfect a degree as in any of the manufactures on which invention has been employed, ſo much to the honour and advantage of this country. Hence ariſe three capital advantages: Firſt; the quantity of force employed, and thence the quantity of work done at a time, may be increaſed at pleaſure. Secondly; even the force of men may be exerted in this way to a greater advantage than while confined, as in the preſent practice, to a particular mode, by the neceſſity of care and dexterity. Thirdly; the labour not only of the aukward and unpractiſed, but of the blind and the lame, may be called in, and a value given to it, little if at all ſhort of what that of the moſt ſkilful and experienced artiſt bears at preſent. The invention, as thus ſtated, is, properly ſpeaking, the invention not of a mode but of a principle; the modes in which that principle may be employed, and the ſpecies of work to the performance of which it may be applied in different circumſtances, with different degrees of advantage, are innumerable. To fulfil the conditions preſcribed

prefcribed by law, the beft and indeed only courfe I can purfue is, therefore, to give fuch a general, and in a manner exhauftive view of the extent of the principle, of the manner of applying it, and of the forts of work to which it may be applied, as to enable the public at large, upon the expiration of my term, to reap the benefit of the invention in its fulleft extent, by fuch directions and inftructions of a general nature, as, in each of the many different forts of work in which it may be employed, may put an intelligent workman in the way of making ufe of the principle to the moft advantage. Drawings are not given, as they would tend rather to confine the direction to a particular mode; whereas words may ferve to convey the inftructions in the moft general way, and with a latitude that will adapt itfelf to whatever variety of circumftances may prefent themfelves, and the better enable the artift to purfue the invention through all its branches. In the common mode of planing a ftraight board, for example, the workman, befides exerting the force neceffary to move the inftrument along, and overcome the refiftance he finds oppofed to him, has

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a number of other points to attend to. Firſt; he has to adjuſt his tool to the board in a proper manner for beginning the ſtroke. Secondly; he has to employ exertion to keep the inſtrument down, ſo as to prevent its paſſing over without cutting. Thirdly; he has exertion to employ again to raiſe it upon its return, in order to ſave the cutting edge from being injured. Fourthly; he has to guide it ſideways, to prevent its ſlipping off. Fifthly; as the board is broader than his plane, he has to examine from time to time if the middle of the board correſponds with the edges, and to take as much care not to cut away too much from ſuch parts, as to cut away enough from others. Sixthly; in many caſes, having had to mark it at the edges, he has from time to time to obſerve theſe marks, and to take care that his ſtrokes conform to them. Upon my principle, all theſe points are accompliſhed by machinery, in manner following: to begin with the ſimpleſt caſe, *viz.* when the board to be planed is already of the form required, and nothing more is wanted than that degree of ſmoothing which a plane will give, when drawn over the board with the ſole

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reſting thereon. Here the board may be laid on the bench in the uſual way, but the plane for this purpoſe muſt be made in the firſt place as broad, at leaſt, as the board, and muſt be capable of cutting the whole breadth of the board at once. Secondly; the ſides of the plane, which I call the cheeks, and which are neceſſarily of a ſubſtance ſufficient for the ſtrength of the plane, may extend below the ſole ſufficiently to ſerve as guides to the plane, in each ſide, on its courſe along the board, and ſhould cover ſo much of the breadth of the iron, if there be any, as does not cut; ſo that ſhaving may be taken from cheek to cheek, in ſuch manner as not to be impeded by their breadth in their paſſage out of the mouth. For making the ſtroke, the plane may be kept down by its own weight, or by being loaded as required; the force neceſſary for this purpoſe being greater or leſs, according to the breadth of the board and other circumſtances; but, though mere weight may ſerve to inſure the continuation of its cutting, when once it has been properly applied, yet, for guiding it upon the firſt application to the end of the board, at the commencement of the

ſtroke, and upon the quitting the board, at the concluſion of the ſtroke, particular precautions or contrivances are neceſſary. The bench, it is evident, muſt be at each end as much longer than the board as to afford a reſting place for the plane, at which places it will reſt upon its cheeks. From this ſituation it will have to riſe at the commencement of the ſtroke, for the ſole to mount upon the board, and it will fall down again, in the ſame manner, upon theſe cheeks, at the concluſion of the ſtroke; the nearer therefore the depth of theſe cheeks is to the thickneſs of the board, the leſs the plane will have to riſe and fall. But, as there muſt always be ſome difference between the two levels, or the iron would not take hold, the ſole of the plane at each end muſt be rounded off, or ſloped up, to enable it to ſlide on and off the board. But this would not do without ſome farther contrivance; whatever were the preſſure employed for keeping the plane to its work, during the continuance of the ſtroke, that ſame degree of preſſure would not do at the commencement or concluſion of it. At the commencement, the fore end muſt be preſſed down hardeſt, that in

in riſing it may be made to aſſume the direction in which it is to cut; ſo, at the concluſion of the ſtroke, the preſſure muſt be augmented at the hinder end, leſt, by the dropping or tilting down of the fore end, the iron ſhould be raiſed from the board before it had reached the end of it. This variation in the preſſure may be inſured by a weight reſting upon the plane, but made capable of traverſing from end to end, and ſhaped in ſuch a manner as not to diſturb the paſſage of the ſhavings. An obſtacle connected with the bench, in ſuch manner as for the movable weight to be carried againſt it by the plane, while the plane itſelf paſſes clear of it, will, by cauſing the weight to ſlide accordingly, ſecure the preponderancy of the part required at each of theſe points. While the plane is off the board, fillets or battens may guide it, or ſecure it from lateral deviation. If the board being finiſhed at one ſtroke is thereupon removed, the plane may be thereupon drawn back without obſtacle or difficulty; but, if a freſh ſtroke is to be given, a contrivance is neceſſary to ſave the cutting edge from being injured in dragging back on the board; for this purpoſe, the

ſole of the plane muſt be lifted up, ſo as to be clear of the board, and the plane in its paſſage back muſt find ſome other ſupport. Amongſt the variety of means, by any of which this effect may be produced, as ſimple a one perhaps as any is as follows. From the upper ſurface of the plane project a bar of wood, or metal, anſwering the purpoſe of a handle, to which the moving force is to be applied; let this handle be connected with the plane, by a pin paſſing through it in a direction tranſverſe to the plane, ſo as to form an axis round which the handle may play, in the manner of a lever, for a ſmall determinate diſtance, in a direction parallel to the length of the plane. The upper (which it may be convenient to make the longer) end of this handle being ſhaped in the manner the moſt convenient for its connection with the moving power; the lower end is forked, or otherwiſe adapted to receive one or more rollers, which, when the handle is erect, extend before the ſole of the plane, and thereby clear it of the wood. In this way, when the moving force draws the plane forward, the handle, by the play it was allowed to have round its axis, is

is made to incline forward, whereby the rollers attached to it are raiſed, in ſuch manner as to leave the ſole of the plane free to drop down upon the work: as ſoon as the moving force acts upon the handle, in a manner to draw the plane back again, it becomes erect, and the rollers are thereby preſſed down below the ſole of the plane, ſo as to receive the weight of it during its return, leaving the ſole and the iron clear of the work. It is true, if there be but one handle of this ſort, then, according as the rollers are nearer to the one or the other end of the plane, the oppoſite end will ſtill bear a part of the weight; but the edge of the ſole being of courſe ſmooth, and rounded off, this ſlight bearing will not be productive of any inconvenience; and, if you fix another roller at this end, juſt even with the ſole, this ſecond roller will take off ſo much of the weight as was left by the firſt. Theſe rollers will of courſe be ſo contrived and diſpoſed as not to damage the work, eſpecially where it is of any of the nicer kinds hereinafter ſpoken of. So much for the moſt ſimple caſe, but in others farther contrivances will be neceſſary. The accuracy of planing depends,

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even in the preſent mode, in ſome meaſure upon the bench; in this new mode, an attention to the conſtruction of that implement is particularly eſſential. For the caſe when the board winds, ſo as to afford no ſurface on which it would lie firm on an ordinary bench, a compound bench may be employed, conſiſting of a middle part and two ſides; the middle part ſerves for the ſupport of the board or piece to be planed, and is capable of being lowered or raiſed at pleaſure; the ſides are made to ſeparate and cloſe horizontally, ſo as to receive between them, and keep ſteady, a piece of any breadth. For this purpoſe they are furniſhed with one or more rows of flat teeth, which, without being long enough to damage the board, are numerous enough (in conjunction with a common ſtop or bench hook) to keep it to its poſition, in ſpite of the weight of the plane, and the tendency which the action of the ſtroke will ſometimes have to draw the plane and board together. The piece being thus fixed, with ſuch part as you think proper to cut off projecting above the ſides of the bench, the plane, being ſet to work, will cut away till its cheeks come down ſo as to touch theſe

theſe bench ſides: which, being out of winding, in reſpect of each other, will inſure the ſame regularity to the ſurface of the piece between them. When one ſurface has been thus planed out of winding, ſo as to lie flat on the bench, the piece may be planed to a parallel thickneſs on an ordinary bench, *viz.* by only making the cheeks of the plane to riſe and fall, and adjuſting them to the thickneſs which is to be taken off. But here it is neceſſary to obſerve, that in planing of boards not very thick, even after the plane-iron has been ſtopped by the cheeks from getting down to this board, the board may at one part of it ſpring up to the iron; and the iron, having thus once got hold of it, may not part with it until it has reduced it below the intended thickneſs to which the cheeks were adapted. To obviate this accident, recourſe muſt be had in ſuch a caſe to the ſort of compound or compreſſing bench above mentioned; and, in caſe of very thin boards, where, though you keep down the edges in manner above mentioned, the middle may notwithſtanding be apt to riſe, there may be heavy rollers, or rollers loaded with weights, let through the ſides of the plane, as near the iron as may be,

and on one or both ſides of it. In this manner, without any great additional conſumption of moving force, the board, however thin, may be effectually kept down flat upon the bench. When the two ſides of a board are brought into parallelſm, as before, in order to bring either of the edges to a ſquare with them, all you have to do is to ſteady it by compreſſion between the ſides of the bench, as in the former caſe, leaving as much above them as you ſee occaſion to cut away; only here, as the ſides of the boards are finiſhed, to ſave them from being indented, you muſt give the teeth of the bench ſides ſome thing by way of a ſheath to bite upon; and one edge of the board, being thus ſquared and ſmoothed, will as before ſerve as a baſis, which, by reſting on the middle part of the bench, will inſure parallelſm to the oppoſite edge. The ſame ſort of bench affords an eaſy means of tapering the piece to any degree of taper, and that as well lengthways as croſſways, in the manner of weather-boarding. Raiſe one end of the middle part of the bench, you taper the piece at that end: raiſe one of the ſides of the bench, you taper the piece at that ſide: having raiſed the middle

dle part of the bench at one end, raiſe the two ſides to any one and the ſame angle, but one of them higher than the other, you may thus taper the board in both ways at once. So, inſtead of letting the plane bring itſelf down, as it works, to the piece to be planed, *viz.* by riſing leſs and leſs after each ſhaving has been taken off, you may make the piece bring itſelf to the plane. To do this, raiſe the middle part of the bench on which the piece reſts, leaving the poſition of the ſides unaltered. But, where the ſides are employed to keep the piece faſt, as in the caſe of thin ſtuff before-mentioned, falſe ſides without them muſt be added, for the plane to run upon; which falſe ſides remain fixed, while all the reſt of the bench is raiſed up: or, what will be eaſier, letting the reſt of the bench remain fixed, lower theſe falſe ſides. This manner of working will admit of the plane's being perfectly confined in all directions, except that of the horizontal or other line, in which it is worked in ſuch manner that all the above mentioned contrivances for ſetting and keeping the plane to its work, and ſaving the edge from injury, are ſuperſeded. A yet remaining way

of producing the ſame effect is, by making the plane ſo as to drop, after each ſhaving, between its cheeks. Any of theſe parallel riſings and droppings may be effected by two or more ſcrews, ſo connected as to be all turned at once. By a proper configuration of the bench, the ſurface of the work may be made to receive curved forms, and thoſe of a very complex nature. In a tranſverſe direction, ſuch forms are already given to the work in the ordinary way of planing; for inſtance, by moulding-planes. In longitudinal direction alſo, the work may now be curved, by giving a correſpondent curvature to the bench ſides; and, by a combination of theſe two ſources of curvature, it is eaſy to ſee that curves of a very complex and ſeemingly irregular nature may be produced. By means of a double motion, another more complicated, but perhaps for ſome caſes an uſeful plane may be made, very much extended in breadth, and of different curvatures at different parts of that breadth; and this, by being made to move tranſverſely, at the ſame time that it is drawn along longitudinally, may preſent to different parts of the work different curvatures at different

ferent periods of its courſe. Barrel-ſtaves, blades of oars, and ſeveral other articles may be worked, and perhaps with advantage, in this manner. So much with regard to the planing a ſingle ſurface at a time; but, where your board or other piece is of ſubſtance enough to admit of your confining it in ſuch manner as to come at more than one ſurface, you may eaſily connect planes together, or compound your plane, ſo as for it to apply itſelf to either or both edges at the ſame time, as to one ſide. In the caſe of a ſingle edge, one means of confining to its work the plane belonging to that edge is, by giving to the plane-iron of the plane belonging to the ſide a diagonal direction, as is ſometimes done in rabbet-planes; or you may confine the plane at the edge, or a plane at each edge, by ſprings or guides. In this manner, edges of boards may receive any moulding, or be rabbetted, or tongued and grooved, at the ſame time that the ſide is planed. Hitherto I have ſpoken only of taking a ſingle ſhaving at a time from each ſurface, though it be the whole breadth of the piece; but irons may be ſo diſpoſed in the plane, one behind and lower than another, as to take off as many ſhavings in thickneſs as you

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pleaſe; and, the piece being fixed, and the laſt and lowermoſt iron adjuſted to the cheeks, of the plane at the proper height, to carry off the whole thickneſs required, and ſo finiſh the planing. In this way, if before the laſt iron you have provided irons enough to take off the thickneſs, the plane, if it has completed its courſe, cannot but have done its buſineſs. In this manner, ſo you apply force enough, you may perform almoſt any planing-work at one ſtroke, though it embrace ſeveral ſurfaces at once. You may diſpoſe irons enough, one after the other, to cut the piece through; and, if you make them narrow enough, ſlitting or plowing may, in this manner, take the place of ſawing. But here it is evident that the difficulty of attaining ſufficient accuracy will increaſe with the depth; the thinner too the irons, that is the narrower the ſlit, the weaker they will be, and the more liable to bend or break; the thicker the irons, the greater will be the reſiſtance to be overcome, and the greater the waſte of wood, which, in ſome inſtances, may be a material object. Minute inſtructions and dimenſions cannot here be given, ſince theſe muſt

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be adapted to the nature of the wood. The above inconveniences may be obviated, in ſome degree, by applying a ſlitting-plane of this ſort to each of the two oppoſite ſides, ſo as for the two planes to meet in the middle at the concluſion of the ſtroke; by which means each will have but half the depth to cut which a ſingle one would have; but, in making of ſuch many-ironed planes, a great deal of accuracy is neceſſary, and if any one of the irons is damaged, or choaks, the operation fails. A better way may be, to employ a number of ſeparate planes, connected ſo as to follow one another, but ſo that each may be preſſed down to the work ſeparately, by its own weight, or otherwiſe: in this way, though choaking were to take place, the bad effect of it may be avoided; for, if any one of ſuch a chain of planes gets choaked, it will only riſe, and paſs over without effect. A depth of ſhaving, correſpondent to this choaked plane, will indeed fail of having been taken, and a correſpondent failure will of courſe take place in the whole depth carried away, in compariſon of what was intended to be carried away, ſo that ſo much of the work will remain undone, requiring a freſh ſtroke; but againſt this inconvenience ſufficient ſecurity

may

may be provided, by only adding a few ſupernumerary planes, over and above the number which, in the event of their not any of them choaking, would be ſufficient; in this caſe, if none of the planes which come before the ſupernumerary ones choak, the ſupernumerary ones will paſs over without effect. As to the mode of connection between the links of ſuch a chain of planes, as ſimple a one as any may be by an oblong frame, the ſides of it furniſhed with perpendicular ſlits, to receive pins projecting from the ſides of each of the planes; the length of the ſlit ſufficient to leave the pins at liberty to play up and down, at the extent of the whole thickneſs which the whole chain of planes is intended to plane away. In the thickneſs of ſhaving which theſe different planes are ſet to take off, there may be ſome difference; the foremoſt ones being ſet the rankeſt, for the ſake of riddance; the hinder ones the leſs rank, for the ſake of ſmoothneſs; but each of them prevented by its cheeks from cutting below the total depth intended. To ſave the length of plane otherwiſe neceſſary to take off the whole thickneſs at a time, the whole breadth of a board may

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be planed into grooves and ridges, and thoſe ridges immediately taken off in the following manner: divide the breadth of your plane-iron into teeth, ſay about one eighth of an inch wide, with intervals equal in width to the width of the teeth; this makes a ſet of channels of that width, with ridges between them of equal width. To bring theſe channels to the depth required, ſay a quarter of an inch, I put four ſuch irons, one behind and below the other, each taking a ſhaving off a ſixteenth of an inch. To cut away the intermediate ridges behind the laſt of theſe toothed irons, I uſe a ſet of ſquare pins, running in and reaching to the bottom of theſe channels; a pin following each tooth, and the whole of them fitted into an iron frame, placed underneath the ſole of the plane. Each pin at its baſe, where it runs along the bottom of the channel, is terminated in, and ſtands as it were on, a horizontal cutter or tooth, ſhaped like the blade of a bricklayer's trowel, being broader than the channel by a full ſixteenth of an inch on each ſide. Each of theſe trowels cuts through half of the adjacent ridge on each ſide; ſo that, between the trowel on the left

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hand of it, and that on the right hand, each ridge is cut away, as it were, at its root. This fort of plane, however, can hardly be made to fuch nicety, but that a fhaving or two of an ordinary plane-iron will be neceffary to fmooth the work. The ufe of this fort of plane is moft confpicuous in the cafe of crofs-grained wood, to which it would otherwife be neceffary to ufe double irons; becaufe double irons, taking fo much thinner fhavings than fingle irons, muft be in proportionably greater number to do the bufinefs: a number which, where the thicknefs to be taken away is confiderable, may be fo great as to render the length of the plane not only expenfive, but cumberfome and inconvenient. Hitherto I have confidered the plane alone as moving, the piece of wood to be planed remaining fixed; but planing may equally be performed by moving the piece, the plane remaining fixed; or even were both to move. The expedient of making the piece move, while the plane is fixed, may, befides being applicable in cafes where the piece is very fmall or fhort, be particularly ufeful where the plane is fo conftructed as to embrace the piece on

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all ſides, whether it have cutters on all ſides or not. In this mode, which ſeems to bear reſemblance to wire-drawing in metal, ſeveral ſorts of work, ſuch as the planing of tree-nails for ſhips, the fluting of pillars, and the forming of rails and baluſters, might be performed, and perhaps to ſome advantage; but there are other configurations given to wood, in the inſtance of which the plane is at preſent either not uſed at all, or uſed in ſuch a way as to perform the buſineſs but imperfectly, in ſpite of all the ſkill and dexterity which can be applied to it. Tenons are ſometimes, for example, planed; mortiſes are not, but are made in a manner in which accuracy depends altogether upon ſkill and dexterity. Both theſe, as alſo all other forms which wood is made to receive for the purpoſe of junction and connexion, may be produced, in this way of planing, upon this ſame principle. As to tenons, at the end of a bench let a plane with cheeks, but no wood before the cutting-iron, be ſo diſpoſed as to move in a channel longitudinally ſtraight, and lying flat on the bench, the depth of the cheeks determining the height at which it moves; then, if any

ſtraight piece to which a tenon is to be formed at the end, (a door-rail for example,) be confined ſtraight and flat on the bench, the depth of the ſhoulder being already cut by a ſaw or other tool, ſuch a plane may be made to cut off, ſhaving after ſhaving, the whole depth of the ſhoulder quite home to the ſawkerf. When the tenon is thus worked down to the proper depth on one ſide, the other may be turned, and treated in the ſame manner. If the tenon were already roughed out by ſawing, or otherwiſe, ſo as not to require more than one ſtroke of the plane, no riſing or lowering of either plane or piece would be neceſſary at each ſhaving. By putting two cutters, the one for the upper the other for the lower ſide, and, if wanted, one for each edge, the whole tenon may be finiſhed at a ſtroke; and, by an alteration in the breadth of, and diſtances between, theſe cutters, tenons of different ſizes may be finiſhed. It is ſcarce neceſſary to obſerve that, againſt croſs-grained wood, double irons, and other precautions againſt the tearing up of the grain, may be employed here, as in other caſes. Neither, in caſes where the extent of the motion required is thus

ſhort,

ſhort, is it neceſſary that there ſhould be cheeks running upon the bench, if the ſtock, or part uſually made of wood, be made to move in the required direction, by being confined within a piece projecting upwards from the end of the bench to the ſame ſtock. Inſtead of theſe cutters, which are calculated to embrace the outſide of tenons, other irons may be adapted proper to finiſh the inſide of mortices, and that either at all the ſides, or at any leſs number of the ſides at a time. For this purpoſe, the greater part of the wood muſt already have been got out of the mortiſe, either by boring, for inſtance, or otherwiſe. The piece in which the mortiſe is to be cut will be laid horizontally acroſs the bench, confined by proper ſtops to receive in the requiſite parts the action of the tool. The cutting out ſcores and dovetails may of courſe be performed in the ſame manner; the former being only a ſpecies of right-angled, the other of acute-angled mortiſe, each wanting one of the four ſides. To theſe operations I give the name of planing, as well as to any of the above; the cutting-inſtrument being employed and governed by guides, as well in reſpect

of the depth to which it is ſet to cut, as in point of direction. With reſpect to the choice of the moving power for all theſe ſeveral operations, and the manner of applying it, nothing need here be ſaid. The choice between wind, water, ſteam, animal ſtrength, and ſo forth, is a conſideration of œconomy, depending on particular circumſtances. In the production of the alternate motion, like that of ordinary planing, if the ſtrength of man is employed in what I have termed a brute way, it may be aſſiſted by declivity, or by adventitious weight; by a man's having to puſh down hill as he makes the ſtroke, and conſequently draw up hill as the plane is brought back free; or by drawing up over a pulley, on the return of the plane, a weight which, being faſtened to the plane, aſſiſts him as it works; or farther force may be produced by a man or men drawing, in any manner, a rope faſtened to the plane, for inſtance, winding it over a barrel by a winch. Having ſhewn that channels in the bench may be made to guide the plane, and that planes ſo guided will do the work, the determining the plane to move along the guides, whatever be the direction

direction of them, is a businefs within the competency of any intelligent mechanic, who I think cannot now be much at a lofs for means of executing the details of any of the fpecies of work above mentioned. In point of œconomy, how far machines thus complicated may, in particular inftances, and under particular circumftances, give an advantage in comparifon of each other, or of the prefent mode of working by hand, is a matter of calculation foreign to the prefent purpofe. In witnefs whereof, &c.

XXXV.

XXXV. *Specification of the Patent granted to* William Murray, *Esq. (commonly called Lord William Murray;) for his Invention and Discovery of extracting Starch from Horse-Chesnuts, by a new and simple Method, at present unknown to any one but himself.*

Dated March 8, 1796.

To all to whom these presents shall come, &c. Now know ye that, in compliance with the said proviso, I the said William Murray, Esq. (commonly called Lord William Murray,) do hereby particularly describe the nature of my said invention, and how it is to be performed, which is in manner following: that is to say; I first take the horse-chesnuts out of the outward green prickly husks, and then, either by hand, with a knife or other tool, or else with a mill adapted for that purpose, I very carefully pare off the brown rind; being particular not to leave the smallest speck, and to intirely eradicate the sprout or

or growth. I next take the nuts, and rasp, grate, or grind them fine into water, either by hand, or by a mill adapted for that purpose. The pulp, which is thereby formed in this water, I wash as clean as possible, through a coarse horse-hair sieve; this I again wash through a finer sieve, and then again through a still finer, constantly adding clean water, to prevent any starch adhering to the pulp. The last process is, to put it with a large quantity of water (about four gallons to a pound of starch) through a fine gauze, muslin, or lawn, so as intirely to clear it of all bran, or other impurities. As soon as it settles, pour off the water; then mix it up with clean water, repeating this operation till it no longer imparts any green, yellow, or other colour to the water. Then drain it off till nearly dry, and set it to bake, either in the usual mode of baking starch, or else spread out before a brisk fire; being very attentive to stir it frequently, to prevent its horning; that is to say, turning to a paste or jelly, which, on being dried, turns hard like horn. The whole process should be conducted as quickly as possible. In witness whereof, &c.

XXXVI.

XXXVI. *Specification of the Patent granted to Mr.* ALEXANDER MABYN BAYLEY, *of the Pariſh of St. Martin in the Fields, Middleſex; for his Invention of a Machine for making freſh Water from Sea-Water, or from Brine-Springs, without boiling; and for making Salt from Sea Water, or from Brine-Springs, with much leſs boiling than in the common way.*

Dated July 9, 1777.—Term expired.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE that, in compliance with the ſaid proviſo, I the ſaid Alexander Mabyn Bayley do hereby declare, that my ſaid invention of a machine for making freſh water from ſea-water, or brine-ſprings, without boiling, which will be pure element, without any ſpirit of ſalt, bitumen, or heterogenous matter, and for making ſalt from ſea-water, or from brine-ſprings, upon a new and particular conſtruction, is to be performed in manner following: to wit; this machine conſiſts of five parts, *viz.* Firſt; a large pair of bellows

bellows on a strong frame. Secondly; an iron stove with a tube or pipe, which conveys the air from the bellows through the fire, into a dodecagon frame or barrel. Thirdly; an iron pan with a groove or channel on its upper edge, to receive the cover or condenser, and with a pipe at the bottom of it, to draw off the salt-water when needful. Fourthly; the dodecagon frame or barrel, covered with flannel, or coarse canvas, which revolves on two concave cylinders; the one to convey the hot air from the stove into the dodecagon frame or barrel, the other to let out the air occasionally. Fifthly; the cover or condenser with a groove or channel on its inside, to convey off the fresh water; on its outside is a pipe which communicates to the groove or channel aforesaid; the upper part of it has a conic roof, and is a reservoir of salt-water to supply the pan when wanted. This machine may be worked by hand, horse, wind, or water. In witness whereof, &c.

XXXVII. *Description of a Loom on a new Construction for weaving slight Silks.* By Mr. SAMUEL SHOLL, *of New Turville-street, Bethnal Green.*

WITH A PLATE.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Silver Medal and Thirty Guineas were given to Mr. SHOLL for this Invention.

HAVING been employed more than twelve years past in the weaving of silk, I have had occasion to observe several considerable inconveniences to which this manufacture is subject. To the removal of these, my attention has been for a long while directed; and I have at length succeeded in the construction of a model, which is entirely new, the utility of which I now beg leave humbly to submit to the critical examination

tion of the Society for the Encouragement of Arts, Manufactures, and Commerce.

The several advantages of this invention are as follow:

1. It is not liable to unsquare; and yet, on any necessary occasion, it may be more easily removed than the old loom.

2. In the construction of it, more than thirty feet of wood are saved.

3. It is much sooner removed, in case of fire, or any other sudden occurrence.

4. It has a very great advantage, with respect to admitting light to the workmen.

5. In case of removal, it may be carried up some stairs which the old loom cannot pass.

6. If room should be wanted for any temporary purpose, the work may be laid aside without injury.

7. It may set up in sloping garrets, which will not admit of the old loom.

8. As the cane-roll posts are fixed to the floor by screws, the porry may be made of any length, by only screwing the cane-roll posts nearer or farther from the breast-roll.

9. The gibbet is formed in the loom; and therefore the trouble of fixing it is prevented.

10. There is an advantage in the bridge of the battons, which was formerly nailed to the block; but in this loom iron pins are put in the block, and partly go through the bridge, faſtened with glue, ſo that the ſilk cannot be injured, as uſed often to be the caſe.

11. The battons riſe as the work riſes, and keep more true.

12. The manner of ſitting to the work obviates inconveniences, and prevents the injury attending the workmen in old looms.

13. As ſome landlords do not care to let their houſes to weavers, on account of their breaking the walls, that inconvenience is alſo removed.

In order to render this improvement the more acceptable, it is ſo contrived as to preſerve in uſe the moſt valuable part of the old materials, ſuch as rolls, battons, counter-meſhes, &c.

With a model leſs perfect than that I now offer, I have aſcertained, by near two years experience, and on one of the niceſt works in the

trade,

trade, the advantages above recited; and to my employers I have given great ſatisfaction.

Explanation of the Figure.

(See Plate XVIII.)

AA. The ſills.

BB. The breaſt-roll poſts.

C. The cut-tree.

DD. The uprights.

E. The burdown.

FF. The battons.

G. The reeds.

H. The harneſs.

I. The breaſt-roll.

K. The cheeſe.

L. The gibbet.

M. The treadles.

N. The tumblers.

O. Short counter-meſhes.

P. Long counter-meſhes.

Q. The porry.

RR. The cane-roll poſts.

S. The cane-roll.

T. The

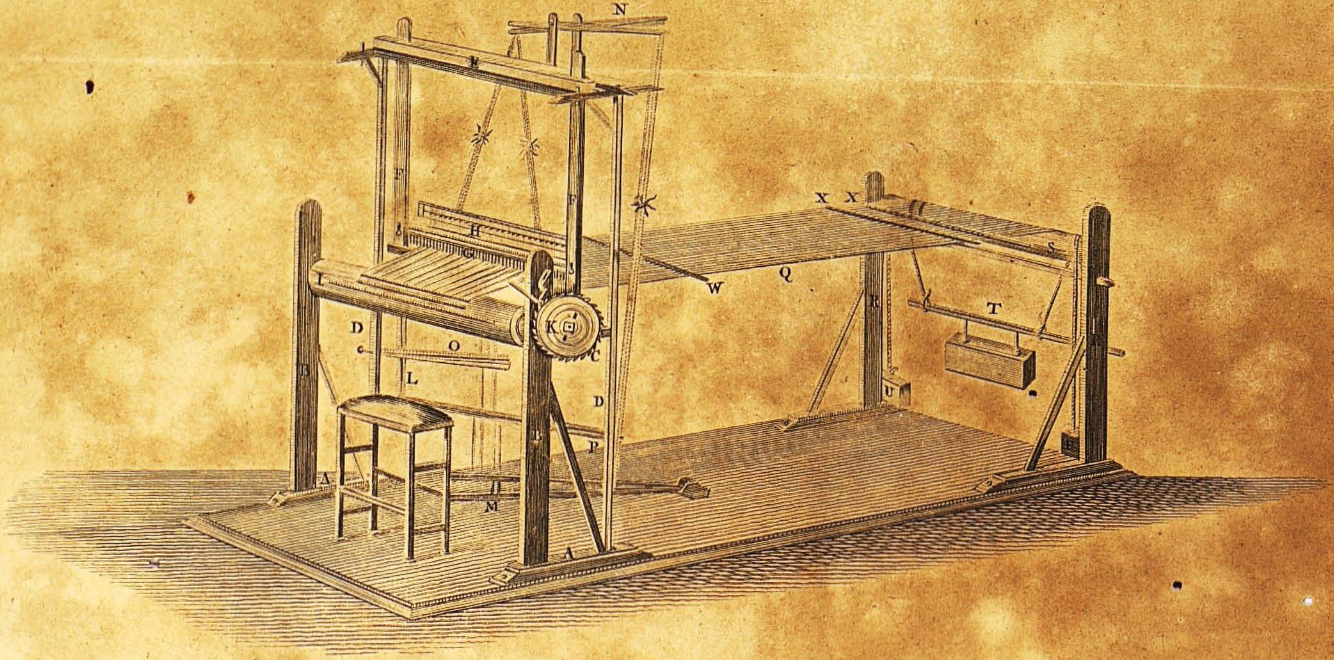
T. The weight-bar and weight.

UU. Counter-weights.

W. The breaking rod.

XX. Crofs rods.

In the introduction to the foregoing defcription it is faid, that it appears, from the evidence of feveral gentlemen converfant in the branch of filk-weaving to which this loom is particularly adapted, that the advantages of this conftruction are; the gaining light; a power of fhortening the porry occafionally, fo as to fuit any kind of work; being more portable, and having the gibbet firmly fixed; alfo a diminution of price, which, compared with the old loom, is as five pounds (the price of a loom on the old conftruction) to three pounds ten fhillings, (the price of one of thofe contrived by Mr. Sholl;) and that, as the proportion of light work is, to ftrong work, as nine to one, this fort of loom promifes to be of very confiderable advantage, particularly in making modes, or other black work.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XXXVIII. *On welding Cast Steel.* *By Sir* Thomas Frankland, *Bart. F. R. S.*

From the Transactions of the Royal Society of London.

THE uniting of ſteel to iron by welding is a well-known practice; in ſome caſes for the purpoſe of ſaving ſteel, in others to render work leſs liable to break, by giving the ſteel a back, or ſupport, of a tougher material.

Ever ſince the invention of *caſt ſteel*, (or bar ſteel refined by fuſion,) it has generally been ſuppoſed impoſſible to weld it, either to common ſteel, or iron; and naturally, for the deſcription in Watſon's Chemical Eſſays (vol. IV. p. 148) is juſt, that in a welding heat it "runs away under the "hammer like ſand." How far the Sheffield artiſts, who ſtamp much low-priced work with the title

title of caſt ſteel, practiſe the welding it, I am ignorant; but, though I have enquired of many ſmiths and cutlers in different parts of the kingdom, I have not yet found the workman who profeſſed himſelf able to accompliſh it. If, therefore, I ſhould deſcribe a ſimple proceſs for the purpoſe, I may be of uſe to the very many who are incredulous on the ſubject.

If any one has made the diſcovery on principle, he has reaſoned thus: caſt ſteel in a welding heat is too ſoft to bear being hammered, but is there no lower degree of heat in which it may be ſoft enough to unite with iron, yet without hazard of running under the hammer? a few experiments decided the queſtion; for the fact is, that caſt ſteel in a *white heat*, and iron in a *welding heat*, unite completely.

It muſt not be denied that conſiderable nicety is required in giving a proper heat to the ſteel; for, on applying it to the iron, it receives an increaſe of heat, and will ſometimes run on that increaſe, though it would have borne the hammer in that ſtate in which it was taken from the fire.

I need

I need scarcely observe, that when this process is intended, the steel and iron must be heated separately, and the union of the parts proposed to be joined effected at a single heat. In case of a considerable length of work being required, a suitable thickness must be united, and afterwards drawn out, as is practised in forging reap-hooks, &c.

The steels, on which my experiments have been made, are Walker's of Rotherham, and Huntsman's, between which I can discover no difference; and, though there may be some trifling variation in the flux used for melting, they are probably the same in essentials.

XXXIX. *Continuation of Mr.* Kirwan's *Experiments on the alkaline Subſtances uſed in bleaching, &c.*

(FROM P. 270.)

SECTION IV.

To diſcover whether any quantity of fixed alkali worth attention exiſts in any ſaline compound, diſſolve one ounce of it in boiling water, and into this ſolution let fall a drop of a ſolution of corroſive ſublimate; this will be converted into a brick-colour, if an alkali be preſent; or into a brick-colour mixed with yellow, if the ſubſtance tried contains lime.

But the ſubſtances uſed by bleachers being always impregnated with an alkali, the above trial is in general ſuperfluous, except for the purpoſe of detecting lime. The quantity of alkali is therefore what they ſhould chiefly be ſolicitous to determine, and for this purpoſe:

First.

Firſt. Procure a quantity of alum, ſuppoſe one pound, reduce it to powder, waſh it with cold water, then put it into a tea-pot, and pour on it three or four times its weight of boiling water.

Secondly. Weigh an ounce of the aſh or alkaline ſubſtance to be tried, powder it, and put it into a Florence flaſk, with one pound of pure water, (common water, boiled for a quarter of an hour, and afterwards filtered through paper, will anſwer,) if the ſubſtance to be examined be of the nature of barilha, or pot-aſh; or half a pound of water, if it contain but little earthy matter, as pearl-aſh. Let them boil for a quarter of an hour; when cool, let the ſolution be filtered into another Florence flaſk.

Thirdly. This being done, gradually pour the ſolution of alum, hot, into the alkaline ſolution, alſo heated; a precipitation will immediately appear; ſhake them well together, and let the efferveſcence, if any, ceaſe before more of the aluminous ſolution be added. Continue the addition of the alum until the mixed liquor, when clear, turns ſyrup of violets, or paper tinged blue by radiſhes, or by litmus, red; then pour the

 liquor

liquor and precipitate on a paper filter placed in a glaſs funnel; the precipitated earth will remain on the filter. Pour on this a pound, or more, of hot water gradually until it paſſes taſteleſs; take up the filter, and let the earth dry in it, until it ſeparates eaſily. Then put the earth into a cup of Staffordſhire ware, place it on hot ſand, and dry the earth until it ceaſes to ſtick to glaſs, or iron; then pound it, and reduce it to powder, in the cup, with a glaſs peſtle, and keep it a quarter of an hour in a heat of from 470° to 500°.

Fourthly. The earth being thus dried, throw it into a Florence flaſk, and weigh it; then put about one ounce of ſpirit of ſalt into another flaſk, and place this in the ſame ſcale as the earth, and counterbalance both in the oppoſite ſcale. This being done, pour the ſpirit of ſalt gradually into the flaſk that contains the earth, and, when all efferveſcence is over, (if there be any,) blow into the flaſk, and obſerve what weight muſt be added to the ſcale containing the flaſks to reſtore the equilibrium. Subtract this weight from that of the earth; the remainder is a weight exactly *proportioned* to the weight of mere alkali, of that particular

ticular ſpecies which is contained in one ounce of the ſubſtance examined; all beſides is ſuperfluous matter.

I have ſaid that alkalies of the *ſame ſpecies* may thus be directly compared, becauſe alkalies of *different ſpecies* cannot, but require the intervention of another proportion; and the reaſon is, becauſe *equal* quantities of alkalies of different ſpecies precipitate *unequal* quantities of earth of alum. Thus, 100 parts, by weight, of mere *vegetable* alkali precipitate 78 of earth of alum; but 100 parts of *mineral* alkali precipitate 170,8 of that earth. Therefore the precipitation of 78 parts of earth of alum, by the vegetable alkali, denotes as much of this, as the precipitation of 170,8 of that earth, by the mineral alkali, denotes of the mineral alkali. Hence the quantities of alkali in all the different ſpecies of pot-aſhes, pearl-aſhes, weed or wood aſhes, may be immediately compared by the above teſt, as they all contain the vegetable alkali; and the different kinds of kelp, or kelps manufactured in different places, and the different ſorts of barilha, may thus be compared, becauſe they all contain the mineral

mineral alkali; but kelps and pot-aſhes, as they contain different ſorts of alkali, can only be compared together by means of the proportion above indicated.

The application of this teſt is founded on the following principles:

Firſt. That a hot ſolution of a free alkali, or of an alkali combined only with fixed air, or ſulphur, can hold no *terreno or metallico neutral* ſalt in ſolution; though it may *alkalino-neutral* ſalts, of quick lime, if the alkali be free from fixed air.

Secondly. That earth of alum cannot be precipitated, either totally or partially, by the hot ſolutions of any *alkalino-neutral* ſalt; and therefore, that its precipitation is always due to the preſence of a free alkali, or at leaſt of an alkali combined only with fixed air, or ſulphur, to whoſe quantity it is always proportional. It is true that quick lime will alſo decompoſe alum; but the preſence of quick lime is eaſily diſcovered, by the addition of a few drops of any mild alkaline ſolution, and by the ſame means as eaſily ſeparated.

Thirdly. That if the earth of alum takes up fixed air, (which would encreaſe its weight,) this air

air will be ſeparated by the heat employed in drying it, or at leaſt by the ſpirit of ſalt poured upon it, and ſo may alſo another heterogeneity which will hereafter be mentioned.

I can ſee but one inaccuracy attending this teſt, and that of little moment; it is this, if the alkali contain ſulphur, this will alſo be precipitated with the earth of alum, and increaſe its weight. The limits of this inaccuracy, at leaſt in common caſes, ſcarcely reach 2 or 3 grains, as we ſhall preſently find.

Sulphur is eaſily detected in any alkaline ſolution, by ſaturating it with an acid; hepatic air is generally developed, and the liquor becomes troubled.

Not only the proportion, but alſo the *abſolute* weight, of alkali in different alkaline ſubſtances, or aſhes, may be found by this teſt, as will appear by the following experiments.

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SECTION V.

Of the Quantity of mere Alkali in different alkaline Subſtances, as exhibited by the aluminous Teſt.

Cryſtalized ſoda. I begin with this, as being the pureſt mineral alkaline ſubſtance, in a dry form, produced by art. Though it contains only $\frac{1}{5}$ of its weight of real alkali, (the remainder being water and fixed air,) yet, the proportion of alkali being invariably the ſame, it is the fitteſt for a ſtandard with which other ſubſtances, containing the ſame ſort of alkali, may be compared. I found that as much of this ſubſtance as would contain 480 grains of mere alkali would precipitate 725 grains of earth of alum, dried, and treated as already mentioned; and conſequently, that 480 grains of *mere* mineral alkali precipitate 725 of earth of alum.

Note. That in this and all the ſubſequent experiments, a little more earth of alum is precipitated than is mentioned, becauſe a little always remains in the filtering-paper, and cannot be had

out

out of it; and I have reaſon to think, by weighing the paper before and after, that this quantity amounts to 3 or 4 grains; but, as this defect is the ſame in all caſes, it does not invalidate the compariſon.

Sweet barilha. The ſolution of one ounce of barilha precipitated 174 grains of earth of alum; therefore, ſince 725 grains of earth of alum require for their precipitation 480 of mere mineral alkali, 174 grains of that earth require 115,2 of mere mineral alkali; and conſequently, one ounce of barilha contains but 115,2 of mere alkali; and one pound of barilha ſhould contain 1382,4 grains. This quantity exceeds, by about $\frac{1}{8}$, the quantity I found by direct analyſis; but poſſibly one pound may contain more than another, for it could ſcarcely happen that I ſhould commit a miſtake of that magnitude.

I muſt not here omit an odd appearance that occurred in this experiment. The earth of alum, in drying, acquired a bluiſh colour; and, when ſpirit of ſalt was poured on it, to diſengage the fixed air it might contain, the blue colour was more developed, and ſome blue particles floated

 in

in the liquor. This seems to proceed from the tinging matter of Prussian blue, which has been found in barilha: the weight of this I have not examined, but it could not exceed one or two grains.

Cunnamara kelp. This was manufactured by Mr. Martin Mealy, and sent to me by Mr. Francis French, an eminent merchant in this city. It is a hard porous black substance, mixed with white and grey spots; its smell sulphureous, and its taste mixed, being that of common salt and alkali. One ounce of it, dissolved in marine acid, lost 24 grains of its weight, which escaped in an aërial form: this air was hepatic.

Another ounce, dissolved in boiling water, left an insoluble residue; which, being heated in a crucible to redness, weighed 165 grains: this residue effervesced with acids, and seemed for the most part calcareous.

The solution by the test of the nitrous solution of silver, evidently contained sulphur; and the Prussian alkali gave manifest signs of iron.

This solution, precipitated 25 grains of earth of alum, and therefore contained 16,5 grains of

mere

mere alkali. During the precipitation of the earth of alum, much hepatic air was emitted, and the earth was ſullied by the ſulphur, though only a few grains of this can be preſumed to be mixed with it.

To find the quantity of ſulphur in this kelp, I diſſolved two ounces of it in pure water, and ſaturated the ſolution with marine acid. The liquor became turbid; and, partly by filtration, and partly by ſpontaneous depoſition, (for ſome of the ſulphur paſſed through the filter,) I obtained 8 grains of ſulphur; which gives 4 grains for each ounce, beſides what exhaled in hepatic air.

In order to eſtimate the quantity of ſulphur which a given quantity of mineral alkali is capable of containing, I diſſolved 400 grains of cryſtalized mineral alkali in ſix times its weight of water; (this quantity of the cryſtals contained 80 grains of mere alkali;) to this I added 80 grains of ſulphur, and boiled them for half an hour. Only 60 grains of ſulphur were diſſolved, by which I found that this alkali can take up nearly $\frac{3}{4}$ of its weight of ſulphur, in the moiſt way; I ſay *nearly*, as ſome earth remained with the undiſſolved ſul-

 phur.

phur. With this ſaturated liver of ſulphur I precipitated a ſolution of alum, and found the precipitate to amount to 130 grains. Now 80 grains of mere mineral alkali can precipitate only 120,8 grains of earth of alum; therefore 9 grains of the above precipitate were ſulphur. Yet this ſmall proportion of ſulphur was very viſible in the earth of alum, when heated to 500 degrees, by its ſtrong yellow colour; therefore, in the precipitation of the earth of alum by kelp, in which no ſulphur was viſible, the proportion was incomparably ſmaller, and no deduction need be made on that account.

There are three methods of deſulphurating kelp, or any other alkalino-ſulphureous compound. The firſt is, by calcining it in an open fire, by expoſing it to a rapid blaſt of air; and for this a very ingenious contrivance was deviſed by Mr. William Dean; the only inconvenience attending it is, that much of the ſulphur will be converted into vitriolic acid, and thus combine with the alkali. The ſecond is by ſaturating it with a vegetable acid, and afterwards calcining it; by which means the vegetable acid will be decompoſed:

composed: if this method could be cheaply executed it would be the best. The third is, by saturating a solusion of kelp with fixed air: this I have endeavoured to effect, by putting a solution of two ounces of kelp into Dr. Nooth's machine for impregnating water with fixed air. The liquor soon became turbid, and emitted a strong hepatic smell; after the sulphur had subsided I drew off the liquor, and with one half of it precipitated a solution of alum. No hepatic smell was now perceptable, and the precipitate amounted to 40 grains. I dare not say that this great increase of power in the alkali was intirely owing to the desulphuration, but some part undoubtedly was; yet the quantity of the sulphur I could collect was very inconsiderable, and mixed with coal-dust. Kelp may also be desulphurated by nitre, as shall hereafter be shewn. According to Dr. Watson, 30 ounces of kelp afforded him 12 ounces of crystalized mineral alkali; consequently 1 ounce would afford ,4 of an ounce, that is 192 grains; of which $\frac{1}{5}$, that is =38 grains, must have been mere alkali. His kelp might have been better than that I used, but it is impossible

that

that his alkali was pure; as mineral alkali, when mixed with ſuch a quantity of common ſalt as is in kelp, can never be thoroughly ſeparated from it, but by proceſſes which he certainly did not uſe; namely, by precipitating a ſolution of ſilver in ſpirit of nitre, eſtimating the quantity of *luna cornea*, and afterwards decompoſing the cubic nitre; or, by ſaturating the alkali with diſtilled vinegar, and diſſolving the neutral ſalt thus formed in ſpirit of wine, which leaves the common ſalt behind.

Strangford Kelp. This was ſent to me by Mr. Braughhall. It was much more denſe, leſs porous, and in appearance approached more to that of a vitrified maſs than Cunnamara kelp; it was at leaſt equally ſulphureous. The ſolution of one ounce of it precipitated only 9 grains of earth of alum; and this earth was much more diſcoloured that that precipitated by Cunnamara kelp.

The inſoluble reſiduum of an ounce amounted to 174 grains.

Vegetable alkali. I found that 480 grains of the pureſt and drieſt ſalt of tartar (making allowance for the quantity of fixed air it contained) precipitated 331,5 grains of earth of alum.

Dantzic

Dantzic pearl-ash. The solution of one ounce of this salt precipitated, in one experiment, 200 grains of earth of alum; and in another 220 grains; at a medium, 210 grains. Then, if 331,5 grains of this precipitate require 480 grains of mere vegetable alkali, 210 grains of this precipitate require 304; therefore, at a medium, an ounce of this substance contains 304 grains of mere alkali; and a pound contains 3648. By my analysis it contained 3477 grains; the difference is 171 grains.

We may now determine which of two or more saline substances, one possessing the mineral, the other the vegetable alkali, is best in its kind; for, that substance is best in its kind which approaches most to its proper standard; 725, that is, the precipitation of 725 grains of alum, being the standard of the goodness of an ounce of a substance containing the mineral alkali; and 331,5 being the standard of the richness of an ounce of a substance containing the vegetable alkali. Thus, if we compare barilha and Dantzic pearl-ash, as the standard of barilha is to the quantity of earth of alum an ounce of it precipitates, so is the standard of

Dantzic

Dantzic ſalt to the quantity an ounce of it precipitates: or, 725 : 174 : : 331,5 : 79,5. By which we ſee, that an ounce of Dantzic ſalt that would precipitate 79,5 grains of earth of alum, would be as good in its kind as an ounce of barilha that precipitates 174. Therefore, ſince an ounce of Dantzic ſalt precipitates 210, it is richer in its kind by the difference between 79,5 and 210.

With reſpect to antacid powers, the mineral alkali is ſtronger than an equal quantity of the vegetable; that is, will ſaturate more acid, nearly in the proportion of 48 to 22; yet it attracts acids leſs, that is, with leſs force and activity, ſince the vegetable will take them from the mineral alkali. But, if the quantities of real alkali be unequal, we may compare their antacid powers in this manner; as the precipitate by an ounce of a ſubſtance containing the mineral alkali is to 48, ſo is the precipitate by an ounce of a ſubſtance containing the vegetable alkali to a number expreſſing its comparative antacid power: thus, with reſpect to barilha and Dantzic ſalt, as 174 : 48 : : 210 : 58 nearly; therefore, the antacid power of Dantzic ſalt is greater than that of barilha, when

when taken in equal quantities, in the ratio of 58 to 48.

Cashup. The best sort, namely, that marked with the cross arrows, is of a bluish grey colour, exceeding hard, and of a semi-vitrified appearance; its smell sulphureous; its taste scarcely alkaline, and it does not attract the moisture of the air. With marine acid, one ounce of it afforded 31 grains of hepatic air. When dissolved in water, the residuum of an ounce was 357 grains of a grey earth, that appeared to be calcareous for the most part: the solution itself was of a yellow colour, and strongly sulphureous. With the solution of alum it did not effervesce strongly, until a good deal was added: the precipitate was of a dirty white, and amounted to 66 grains, of which two appeared to be sulphur. Hence its quantity of vegetable alkali is nearly 93 grains *per* ounce.

Mr. Clarke's refined ash. This I obtained from Mr. Clarke himself. It is of a yellowish-white colour, with greenish spots; many pieces are externally white, and internally green; it is moderately hard, of a very sharp taste, and effervesces with acids.

An ounce of this ſubſtance, diſſolved in twelve ounces of boiling water, did not efferveſce with acids, but precipitated the ſolution of corroſive ſublimate yellow and red, as lime-water does, and left a reſiduum of 17 grains, which was evidently calcareous. A ſolution of two ounces of this ſubſtance, being impregnated with fixed air in Doctor Nooth's machine, depoſited 5 grains of mild calcareous earth; but a ſolution made in three or four times its weight of water, or without the aſſiſtance of heat, contained no lime, and efferveſced ſlightly with acids: when this ſalt has been ſome time expoſed to the air, its ſolution contains no lime.

A ſolution of one ounce of this ſalt precipitated 89 grains of earth of alum, and therefore contained 129 grains of mere vegetable alkali, to which if we add 17 grains of inſoluble earth, we ſhall find that the remainder of the ounce, namely, 334 grains, conſiſted of neutral ſalts, namely, digeſtive ſalt, and perhaps vitriolated tartar, in ſmall quantity. To prove the exiſtence of theſe, I ſaturated an ounce of the ſolution of this refined aſh with the nitrous acid, and then dropped into

it

it the nitrous solution of silver; this latter was immediately precipitated in a curdy form, which, as the alkaline part was saturated, could proceed only from the marine acid contained in the digestive salt.

In the report of the committee of the house of commons, dated April, 1788, Mr. Clarke delivers an account of his method of manufacturing this salt. He mixes five parts of weed or wood ashes with one part of quick lime, and suffers them to lie together in a heap, for six, nine, or twelve months; then extracts a ley from them, which he evaporates to dryness. By suffering the lime and ashes to stand together for so many months, he imagines that the common salt contained in the ashes is decomposed, and the quantity of alkali thus increased; but, though it is possible to decompose common salt by quick lime, as Mr. Scheele has shewn, yet this decomposition is effected by a very different management; and if, in the first part of Mr. Clarke's process, such a decomposition were obtained, a recomposition would speedily be effected in the second part of his process. For, supposing the

marine acid to quit its alkaline baſis and unite to the lime, yet, when the alkaline ſalt and marine ſelenite are both drawn off into the ley, the alkali immediately decompoſes the marine ſelenite, and reunites to its acid, according to the well-known laws of chemical affinity; ſo that, by this long *maceration*, (as he calls it,) no advantage whatever is gained. However, Mr. Clarke's ſalt is undoubtedly a valuable preparation for the purpoſe of bleaching, but may be obtained in a ſpace of time incomparably ſhorter than he requires.

The neutral ſalts, contained in the ſolution of Mr. Clarke's refined aſh, do not proceed from any error in his proceſs, but from the bad quality of the aſhes he employs.

Common Iriſh weed-aſhes. I obtained a parcel of theſe aſhes from Mr. Clarke; they were of a looſe texture, dark grey colour, and ſalt taſte, mixed with charcoal, brick-duſt, and other impurities. I choſe the cleaneſt, and ſifted them. One ounce of them loſt, by gentle drying, 47 grains, and, in a red heat, 72 grains more.

Twelve ounces of the undried aſhes, being lixiviated, left a reſiduum which, when dried, weighed

weighed 4214 grains. The solution was reddish, and replete with extractive matter; it afforded a large quantity of digestive salt, some vitriolated tartar, and very little alkali.

Two ounces of the same ashes, being gently heated to a slight degree of redness, lost 186 grains of their weight. One ounce of this calcined ash, being boiled in six ounces of water, left a residuum of 344 grains, and consequently contained 136 grains of saline matter; but, of this saline matter, only 22,4 grains were pure alkali, for the solution precipitated only 15,5 grains of earth of alum; an hepatic smell was perceived during the precipitation of the alum, and the earth was of a dirty colour.

TO BE CONCLUDED IN OUR NEXT.

XL. *On the Means of making Bread from Rice alone.*

From the *Journal des Sciences, des Lettres, et des Arts.*

THE art of making bread from rice, though much ſpoken of, ſeems to be very little known. In Chomel's dictionary it is ſaid that bread may be made of rice, but there is no account of the means by which it is to be done. The book called *La Maiſon Ruſtique* goes rather farther; for, it informs us that this kind of bread is made by mixing together the flour of rye and that of rice. The firſt of theſe books therefore may be conſidered as ſaying nothing, ſince it is abſolutely impoſſible to make bread of the flour of rice (which is harſh and dry, like ſand or aſhes) by treating it in the manner in which wheat-flour is treated. The manner of uſing rice-flour deſcribed in the ſecond book, is but an uncertain remedy in caſe of want; for, if we have no rye, we cannot, according to that book, make uſe of rice-flour for making

making bread, becauſe an equal quantity of rye-flour is ſaid to be neceſſary for that purpoſe; and conſequently, in countries where no rye is grown, it would be impoſſible to make bread of rice, however great the want of bread might be.

I therefore think it my duty to ſupply that information which is wanting in the two books above mentioned, by deſcribing a method by which excellent bread may be made from rice alone, which method I learned from the natives of America.

The firſt thing to be done to the rice is, to reduce it into flour: this may be done by grinding it in a mill, or, if we have not a mill, it may be done in the following manner. Let a certain quantity of water be heated in a ſaucepan or cauldron; when the water is near boiling, let the rice we mean to reduce into flour be thrown into it: the veſſel is then to be taken off the fire, and the rice left to ſoak till the next morning. It will then be found at the bottom of the water, which is to be poured off, and the rice put to drain upon a table placed in an inclined poſition. When it is dry, it muſt be beat to powder, and paſſed through the fineſt ſieve that can be procured.

When

When we have brought the rice into flour, we muſt take as much of it as may be thought neceſſary, and put it into the kneading-trough in which bread is generally made. At the ſame time we muſt heat ſome water in a ſaucepan or other veſſel, and, having thrown into it ſome handfuls of rice, we muſt let them boil together for ſome time: the quantity of rice muſt be ſuch as to render the water very thick and glutinous. When this glutinous matter is a little cooled, it muſt be poured upon the rice-flour, and the whole muſt be well kneaded together, adding thereto a little ſalt, and a proper quantity of leaven. We are then to cover the dough with warm cloths, and to let it ſtand that it may riſe. During the fermentation, this paſte (which, when kneaded, muſt have ſuch a proportion of flour as to render it pretty firm) becomes ſo ſoft and liquid that it ſeems impoſſible it ſhould be formed into bread: it is now to be treated as follows.

While the dough is riſing, the oven muſt be heated; and, when it is of a proper degree of heat, we muſt take a ſtew-pan of tin, or copper tinned, to which is fixed a handle of ſufficient length to reach to the end of the oven. A little water

water muſt be put into this ſtew-pan, which muſt then be filled with the fermented paſte, and covered with cabbage or any other large leaves, or with a ſheet of paper. When this is done, the ſtew-pan is to be put into the oven, and puſhed forward to the part where it is intended the bread ſhall be baked; it muſt then be quickly turned upſide down. The heat of the oven acts upon the paſte in ſuch a way as to prevent its ſpreading, and keeps it in the form the ſtew-pan has given it.

In this manner pure rice-bread may be made; it comes out of the oven of a fine yellow colour, like paſtry which has yolk of eggs over it. It is as agreeable to the taſte as to the ſight; and may be made uſe of, like wheat-bread, to put into broth, &c. I muſt, however, obſerve that it loſes its goodneſs very much as it becomes ſtale.

It may be here remarked, that the manner in which Indian corn is uſed in France, for making bread, can only produce (and does in fact produce) very bad dough, and of courſe very bad bread. To employ it advantageouſly, it ſhould be treated like rice, and it may then be uſed, not only for making bread, but alſo for paſtry.

XLI. *Deſcription of a movable Table, for the Uſe of Engravers; invented by the Abbé* JOSEPH LONGHI, *of Monza.*

WITH A PLATE.

From the TRANSACTIONS of the PATRIOTIC SOCIETY of MILAN.

A Gold Medal was given to the Abbé LONGHI for this Invention.

THE art of engraving upon copper, which was at firſt invented to multiply and preſerve copies of the beſt pictures of the moſt able painters, and portraits of the moſt famous men, and which has ever ſince its invention been much eſteemed, is at preſent in ſuch repute in every civilized nation, that its productions are become of great conſequence, even when conſidered as an article of commerce; and, when this art is followed by young men who have both an inclination and a genius

genius for it, what advantage may it not produce to their country, and to society in general? But it often happens, as history testifies, that those artists who apply themselves the most assiduously to it fall early victims to their assiduity, so that their first essays become their last works. I myself remember, with great concern, several who have been taken from this world by a death more or less premature. Considering what could be the cause of this evil, as it was by no means difficult to discover, I found it to proceed from the very hurtful attitude in which the engraver is placed while he is at work; for, in engraving a plate, even of a middling size, if the plate be placed horizontally upon a cushion, as is usual, it is impossible to perform the work without a very injurious curvature of the body; which, by being repeated as often as is necessary in the course of the operation, lays the foundation of those complaints which so often prove fatal to artists. It is however certain that, besides this cause, many others may have contributed to those disorders which have deprived us of many excellent engravers, but the most evident cause is in

the art itſelf. Wherefore, inſtead of being ſurpriſed at their unhappy fate, I cannot help conſidering thoſe who have lived to an advanced age as wonderful inſtances; a very ſtrong conſtitution, (which, however, is ſeldom the lot of thoſe who have great talents,) taking exerciſe, leſs aſſiduity in their labour, and a power of performing their work without carrying their eyes very near it, may have exempted them from the common fate of their fellow-artiſts.

Inſtead of truſting to theſe unfrequent examples, I thought I ſhould do a more uſeful thing by contriving ſuch a table, for the uſe of engravers, as is here deſcribed. My intention was that thoſe artiſts ſhould be able to work, either ſtanding or ſitting, without bending the body; for that reaſon I began by placing the copper-plate upon a deſk. It was then neceſſary to be able to turn it about as occaſion required: for this purpoſe, a pivot or axis in the centre, upon which it might revolve, would ſuffice; but I ſoon found that, upon one centre, it would not be poſſible to execute properly the various lines, in ſo many different directions as would be required.

It

It became therefore alſo neceſſary that the board, upon which the plate was to be fixed, ſhould have a great number of holes underneath, by which it might be put upon the axis or pivot in any part, as occaſion might require; and as theſe holes, if made of a circular form, would perhaps not be all exactly of the ſame ſize, (either from the difficulty of making them ſo originally, or from ſome of them being oftener made uſe of than others,) which conſequently would take from the machine that ſteadineſs which the artiſt always finds eſſential to his work, I thought it would be better to make them ſquare, and, of courſe, to make that part of the axis which fits into them ſquare alſo. Below this ſquare part, the axis is round, and turns in a ſocket, ſo that there is no danger of its becoming either too looſe or too tight. In this manner I had a table made, and I find it to anſwer the purpoſe for which it was intended in the moſt complete manner. Indeed I find it much more commodious for engraving than any other method; for, when it is neceſſary to engrave in the corner of a plate, if we turn the plate upon a cuſhion, and ſupport it with

with the left hand, (as is the ufual way,) that hand finds it difficult, from the weight of the plate, to keep it quite motionlefs; and the fmalleft motion in the plate renders it impoffible to perform the work properly, confequently that part of the plate is worfe executed than the reft: but, upon my table, where the plate is fixed upon a pivot or axis, and fupported by a projecting part under it, the left hand has much lefs to do, and the plate always turns round parallel to what it refts upon.

Thus I have given an account of the motives which induced me to contrive this table, and of the manner in which I have executed it. It has been approved by Signor de Vangelifty, profeffor of engraving at Milan, (who, upon feeing it, immediately made trial of it,) and by the Imperial Academy of Vienna; I therefore take the liberty to prefent the foregoing account of it to the Patriotic Society, with a figure of it, trufting it will be found not lefs ufeful to artifts than to the art itfelf.

DE-

Description of the Figures.

(See Plate XIX.)

Fig. 1. repreſents the whole machine, as it is uſed.

A. Copper-plate on which the engraving is to be made.

a a a a a a a a. Screws by which the plate is affixed to the movable board B.

B. The upper or movable part of the table. It conſiſts of a thin plank, to the bottom of which is united the iron plate repreſented in Fig. 3.

C. The under-board, which is made to riſe and fall at pleaſure, in the manner of a deſk, by means of a pair of hinges; in the middle of it is a pretty thick axis.

D. The foot by which the deſk is ſupported at any required height.

E. The frame of the table.

Fig. 2. The under-board or deſk.

F. A circle of iron, through the middle of which protrudes that part of the axis marked H. (In Fig. 4.)

G.

G. A larger circle of iron, of the same height as the circle F; it serves for the movable board B to rest upon, as it is turned round.

Fig. 3. The movable board B, with the iron plate fixed to it. The square holes in this plate must exactly fit that part of the axis which protrudes; and the plate itself must project so much from the board, as to take in the said part of the axis conveniently.

Fig. 4. The axis, upon a larger scale than the other figures, and out of its socket.

H. The square protruding part, which fits into the holes of the iron plate.

I. A round part, of the same size and height as the hole in the circle F, (in Fig. 2,) in which it turns.

K. A larger round part, which turns under the circle F, and is by it kept in its place.

[Printed by J. NICHOLS, Red-Lion Passage, Fleet Street, London.]

Fig. 1

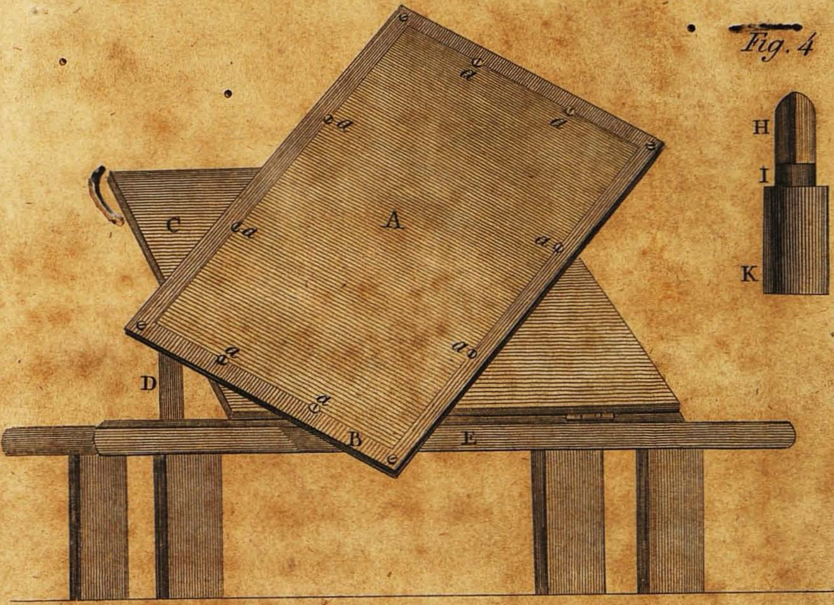


Fig. 2

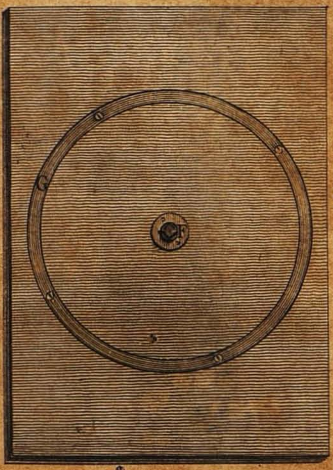
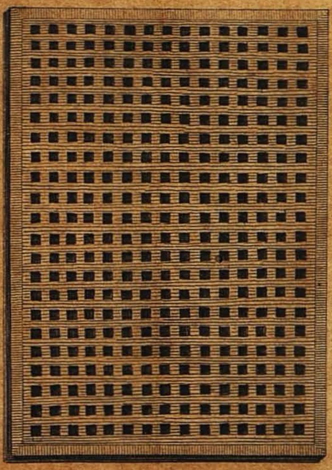


Fig. 3



REPERTORY
OF
ARTS AND MANUFACTURES.

NUMBER XXX.

Printed by JOHN NICHOLS, Red-Lion-Paſſage, Fleet-Street, London.

XLII. *Specification of the Patent granted to* ROWLAND BURDON, *of Harley-ſtreet, Cavendiſh-ſquare, in the County of Middleſex, and of Caſtle Eden, in the County of Durham, Eſq. M. P. for his Invention of a certain Mode or Manner of making, uniting, and applying, caſt-iron Blocks to be ſubſtituted in Lieu of Keyſtones, in the Conſtruction of Arches.*

WITH A PLATE.

Dated September 18, 1795.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that, in compliance with the ſaid proviſo,

proviso, I the said Rowland Burdon do hereby declare, that my invention consists in applying iron, or other metallic compositions, to the purpose of constructing arches, upon the same principle as stone is now employed, by a subdivision into blocks easily portable, answering to the keystones of a common arch, which, being brought to bear on each other, gives them all the firmness of the solid stone arch; whilst, by the great vacuities in the blocks, and their respective distances in their lateral position, the arch becomes infinitely lighter than that of stone; and, by the tenacity of the metal, the parts are so intimately connected, that the accurate calculation of the extrados and intrados, so necessary in stone arches of magnitude, is rendered of much less consequence. Fig. 1. (Plate XX.) represents a block of cast iron, 5 feet in depth from A to A, and 4 inches in thickness; having three arms B, B, B, and making a part of a circle or ellipsis: the middle arm is 2 feet in length from B to C, and the other two are in proportion. On each side of the arms are grooves, ($\frac{3}{4}$ of an inch deep, and 3 inches broad,) for the purpose of receiving malleable or bar iron; and in each arm are

are two bolt-holes. D (Fig. 2.) repreſents two of theſe blocks placed together, and the joints confined to their reſpective poſitions by the bar-iron on each ſide of the arms, as at E, E, E; which, with other ſimilar blocks, ſo united and bearing upon each other, become a rib. Fig. 3. and F, F, Fig. 2. are hollow tubes, 6 feet long, and 4 inches in diameter, having ſhoulders at each end, with holes anſwering to thoſe of the blocks. G is a block of another rib, connected with the former by the tubes F, F, placed horizontally. Through the holes in the ſhoulders and arms of the block, and bar-iron, are bolts, (faſtened with cotterels or forelocks,) as at H, H, H, H. The blocks being united with each other in ribs, and the ribs connected, and ſupported laterally, by the tubes, as above deſcribed, the whole becomes one maſs, having the property of key-ſtones cramped together. The blocks and tubes above ſpecified are thoſe intended to be uſed in the conſtruction of the arch of the bridge, now erecting by me, acroſs the river Wear, at Wearmouth, near Sunderland, in the county of Durham. The arch is a ſegment of a circle, whoſe

chord or ſpan is 236 feet; its verſed ſine or height 34 feet; and its breadth 32 feet, conſiſting of ſix ribs: but the ſizes of the blocks, tubes, and other parts, with the number of ribs and arms in the blocks, muſt be ſuited to the dimenſions, form, and uſe, of the arch. In witneſs whereof, &c.

The preceding Patent appearing to us to be very intereſting, as exhibiting a new Principle in the Conſtruction of Iron Arches, we truſt the following Account of the firſt Bridge wherein that Principle has been adopted, (with a View thereof, Plate XXI.) *with which, at our Requeſt, Mr.* Burdon *has favoured us, will not be unacceptable to our Readers.*

From the encreaſing population and trade of Sunderland and the two Wearmouths, the ancient ferry, which was almoſt in the centre of the harbour, was become very inſufficient, and unſafe; inſomuch that frequent inſtances occurred of the

loſs

Fig. 1.

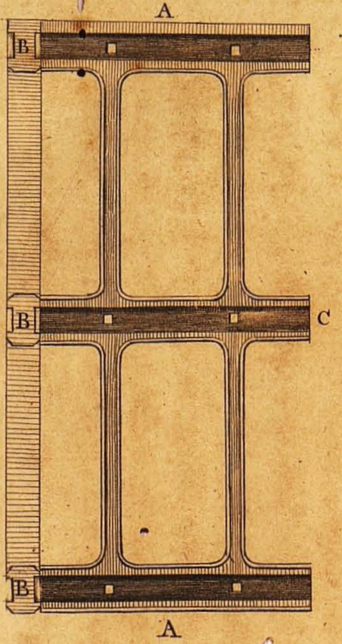


Fig. 2.

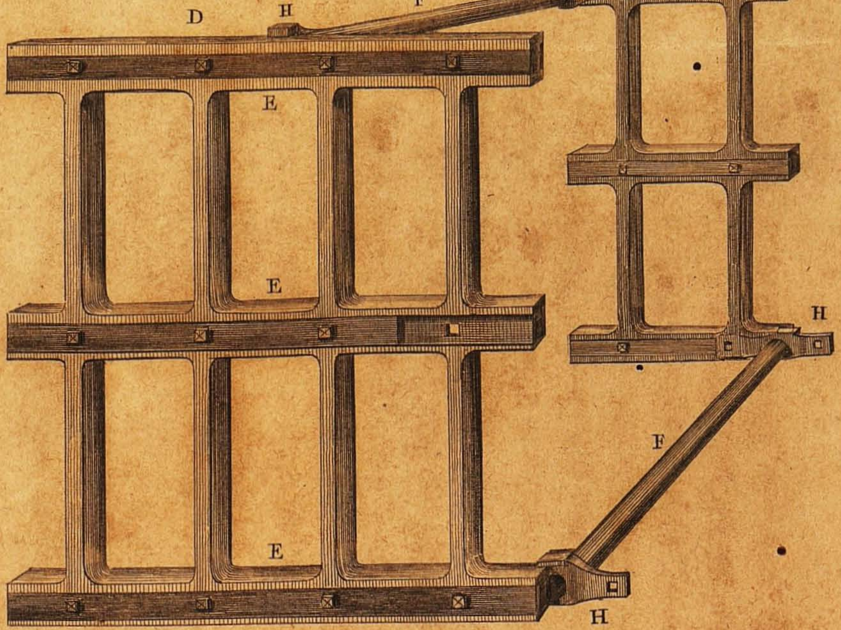
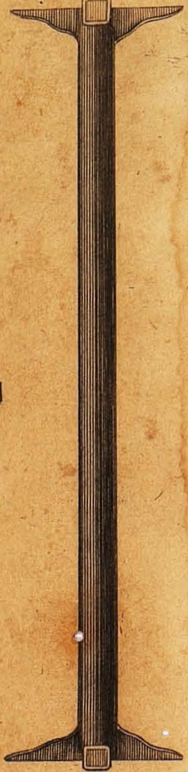


Fig. 3.



Scale of Feet.

12 6 0 1 2 3 4 5

loſs of lives, independent of the conſtant delay and diſappointment occaſioned to all deſcriptions of people.

Under theſe circumſtances, Mr. Burdon, who had previouſly procured a turnpike-road from Stockton to Sunderland, was early in expreſſing his wiſhes for the accommodation of a bridge acroſs the Wear, as near Sunderland as poſſible. Being returned to Parliament by the county of Durham, in the year 1790, he began to move in the buſineſs during the enſuing year, and an act of Parliament for a bridge was, with ſome difficulty, obtained in 1792. At firſt a ſtone bridge was propoſed, of 200 feet ſpan, and 80 feet to the crown of the arch; but, the plan, with the eſtimate, being referred to perſons of ſkill, the extent of expence appeared beyond all reaſonable bounds; and, upon ſearching for foundations, none were to be found within the limits of the ſpace covered by the tide, which flowed between rocky ſhores, diſtant from each other, in the narroweſt part, about 240 feet. Another difficulty alſo aroſe from the ſituation being ſo near the mouth of the river, and perpetually oc-

cupied

cupied by the craft of the coal, lime, and other trades which could not admit even a momentary interruption. From the attempts at conſtructing bridges of iron by the Coalbrook-Dale Company, and alſo by Thomas Paine, Mr. Burdon, though he diſapproved of their principles, conceived the idea of making uſe of that metal; adhering however to the ancient conſtruction of bridges, by the ſubdiviſion of the parts of the arch, in the manner of key-ſtones; and taking advantage of the ductility and tenacity of iron, to produce an arch of that metal, at leaſt fifteen times lighter than a correſponding arch of ſtone, and capable of being put together upon an ordinary ſcaffold, inſtead of an accurate centre, in an infinitely leſs ſpace of time.

After having cauſed an experimental rib to be caſt, and ſet up, by Meſſrs. Walkers of Rotheram, under the direction of Mr. Thomas Wilſon, Mr. Burdon brought forward a propoſal, to the town of Sunderland, and the county, of conſtructing a bridge, on his principles, over the Wear, between the Wearmouths, immediately adjoining to Sunderland and its harbour. His pro-

propoſition was adopted; and the foundation-ſtone was laid on the North ſide, on September 24, 1793. To the ſuperintendance of the execution of the work, Mr. Thomas Wilſon of Sunderland was appointed, through whoſe indefatigable zeal the bridge was rendered paſſable, and opened for the accommodation of the public, in the preſence of a vaſt concourſe of people, on Auguſt 9, 1796. The arch is a ſegment of a large circle; its ſpan is 236 feet; the height from low water to the ſpring of the arch is about 60 feet; and the verſed ſine 34; producing ſo flat an arch, that ſhips of 200 or 300 tons may paſs under it, with equal facility, within fifty feet on either ſide of its centre; having 94 feet clear at low water, and abundant depth in the mid-ſtream. The bridge conſiſts of 6 ribs, at 5 feet diſtance from each other: the ſpandrils are compoſed of caſt-iron circles. The 6 ribs were put together, over the river, in the ſhort ſpace of 10 days. The ſuperſtructure is of timber, planked over to ſupport the carriage-road, which is compoſed of marle, limeſtone, and gravel, with a cement of tar and chalk immediately upon the planks, to preſerve them.

them. The whole width of the bridge is 32 feet; and, on each ſide, is a footway of ſubſtantial flags, having an iron paliſade, with lamp-poſts of timber at intervals. The weight of the arch is calculated to exceed 900 tons, of which 260 tons are iron. Of 28 parts of the iron, 23 are caſt, and 5 are wrought iron.

The expence of conſtructing the bridge will amount to above £.26,000, of which £.4,000 was ſubſcribed by different gentlemen, and the remainder by Mr. Burdon. The tolls, which are the ſame as thoſe of the ancient ferry, are ſubjected, by the act, to pay £.5 *per Cent.* on the capital, if equal thereto; and all accumulations beyond that are to go to diſcharge the capital.

XLIII.

XLIII. *Specification of the Patent granted to Mr.* Elias Carpenter, *of the Neckinger, in the Pariſh of St. Mary Magdalen, Bermondſey; for his Invention of a Method of bleaching Paper in the Water-Leaf or Sheet, and ſizing it, without drying; whereby the Manufacture of it will be improved, by ſhortening its Proceſs, leſſening its Expence, and conſiderably increaſing its Value.*

Dated Nov. 19, 1795.

TO all to whom theſe preſents ſhall come, &c. Now know ye that, in compliance with the ſaid proviſo, I the ſaid Elias Carpenter do hereby declare, that the nature of my ſaid invention, and the manner in which the ſame is to be performed, is hereinafter particularly deſcribed and aſcertained: that is to ſay; I provide a ſtout deal box or caſe, which muſt be perfectly cloſed, capable of confining water or ſteam; the cover on the top

I make to let into a groove, the dimenſions of which muſt be regulated by the ſize of the paper intended to be bleached in it. One I have made for fool's-cap paper is three feet four inches ſquare, and three feet nine inches deep, with a hole cut in one ſide, near the top, to receive the neck of a retort. In this caſe I put a falſe bottom of deal, bored full of holes; which ſaid bottom, including the feet on which it ſtands, takes up a ſpace of about five inches. I have alſo four deal frames made to fit into the ſaid box or caſe, with two croſs bars in each, diſtant about fifteen inches from each end, leaving a ſpace in the centre of about four or five inches: theſe frames have feet which make their height about ten inches. The firſt of theſe frames ſtands on the falſe bottom; the ſecond on the firſt; the third on the ſecond; and the fourth on the third. I then put into the ſaid box or caſe, under the falſe bottom, a proportion of a certain liquid which I ſhall hereafter deſcribe; the uſe of which liquid is for the preſervation of the health of the operator. In my frames I have a groove cut in the inſide of each end, and another facing each end in the croſs bars;

bars; theſe grooves receive the ends of the laths on which the paper hangs. Much difficulty aroſe in finding a contrivance for hanging the paper on. Lines, on account of their being ſo cloſe, were particularly inconvenient and tedious; and thoſe which would be moderate in price gave a ſtain to the paper. Wood was ſubject to the ſame complaint, and, being cut ſo thin as was neceſſary, twiſted and warped in all forms; and all metal would ruſt or corrode in the operation. Nothing therefore appearing ſo convenient and cheap as glaſs, I procured from ſome glaziers the cuttings of ſaſh-ſquares, in large quantities of ſtrips, from $\frac{1}{8}$ to $\frac{1}{4}$ of an inch broad, and about fifteen inches long. Thus provided, I took my paper, when preſſed in the packs in its wet ſtate, and, laying one of the ſtrips of glaſs in the middle of the pack, I turned about four ſheets over on it, and placed it edgeways in a groove of one of the frames; then a ſecond the ſame way, placing it quite cloſe to the firſt: thus I proceeded until the frame was filled. In like manner I proceeded with the remaining frames, placing them in the box or caſe as before deſcribed, (making it in the

 whole

whole to contain about five reams,) the cover of which I place on, and either close it with pipe-clay, or strips of paper pasted on, which latter I prefer, as the most cleanly. I then lute the neck of a glass retort in the hole of the box or case before mentioned, containing manganese, sea-salt, and vitriolic acid; the proportions of which I have frequently varied, without discovering any very great difference in their effects; but have generally found equal quantities of manganese and sea-salt, and about $\frac{5}{6}$ of their weight of the vitriolic acid, have answered best. The manganese and salt must be well mixed together, and put into the retort; then the vitriolic acid must be mixed with an equal quantity of water impregnated with the fumes of burning sulphur, and put to the other ingredients: these mixtures after standing a short time require a moderate heat, which I have, from repeated experiments, found most conveniently communicated by boiling water. The paper, after having been exposed about eight or ten hours to the vapour or steam arising from this preparation, will be found sufficiently whitened, and may be taken from the box or case, and sized

with

with the following ſize: that is to ſay; take one hundred weight of pieces of ſkins of which ſize is uſually made, and, after boiling it to a due conſiſtence, and ſtraining it, mix with it the following ingredients; *viz.* fourteen pounds weight of alum, ſeven pounds of calcined vitriol, and one pound of gum arabic: this quantity will make ſize enough for about fifty reams of fool's-cap paper; then preſs it, and finiſh in the uſual way. This proceſs will anſwer extremely well for a rag that is devoid of ſheaves, and wants only a brightneſs of colour; but, where the rag is of a coarſe bad quality, abounding with ſheaves, it will require the following previous preparation; *viz.* I prepare a lixivium from equal quantities of pearl-aſh and quick lime freſh from the kiln, in the proportion of about four pounds to each hundred weight of the article; I pour on water, by degrees, until the lime is ſlacked, and mix them well together, then pour on a large quantity of water, ſtirring it well ſeveral times; after which I ſuffer it to ſtand until the ſolution is clear, which I draw off, adding more water to the reſiduum, until all the ſalts of the aſhes are entirely diſſolved;

then

then I draw off the clear and mix it with the former, and, if not ſufficient for the purpoſe, I add more water to the ſolution. With this lixivium I either macerate my rag, or boil it, as its ſtate and condition may require; the firſt of which I prefer, as the moſt cleanly, as well as the moſt economical, but the latter is the moſt expeditious and effectual; and, when working a cloſe-wrought rag, made of a hard twiſted thread, and abounding with ſheaves, it will be found neceſſary to paſs it through a waſhing engine, to open it, and give the lixivium and bleaching principle free acceſs to its internal parts. After it hath been thus macerated or boiled, until the ſheaves are extirpated, which will take a longer or ſhorter time, according to the quality and texture of the rag, it is then either to be preſſed, or ſtand in ſome convenient receptacle to drain away the ſuperfluous water, and then put into the box or caſe prepared for bleaching the paper, or any other box, cheſt, or caſe made of wood, of any ſhape or dimenſions, only obſerving it is perfectly tight. I have uſed frequently, for this purpoſe, caſes three feet ſquare, and about two feet three inches

deep.

deep. The noxious vapour which iſſued from the bleaching-caſes immediately on their being opened, having made ſeveral of the people employed therein extremely ill, and having experienced the pernicious effects of it ſeverely myſelf, I turned my attention to a preventive; and, conſidering the attractions of all alkalies with acids, I diſcovered, after trying various means, that the lixivium which we have always at hand anſwered the purpoſe fully. When I have put it in too ſtrong, or in too great a quantity, its effects have been curious; in ſeveral of thoſe trials, after putting in my lixivium of various ſtrengths and quantities, laying on my falſe bottom, and throwing in the article thereon, to the amount of at leaſt one hundred weight and a quarter in each caſe, I have found on opening, after ſtanding the uſual time of eight or ten hours, the caſe which had the weakeſt portion of the lixivium well done throughout; where it was a little ſtronger, one ſmall ſpot in the centre had the colour untouched; and, where it was ſtrongeſt, one large globular form in the middle, of about eighteen inches diameter,

meter, was as full of colour as when put in; while all round, top, bottom, and ſides, particularly the bottom, was purely white. This I attributed to the powerful attraction of the lixivivm, drawing the gaz down at the ſides and corners, where it would find an eaſier paſſage than in the centre, where it lay in a more ſolid body. One gallon of the ſecond running of the lixivium will be generally found a proper quantity for every hundred weight, to draw the bleaching power into the pulp, and render the proceſs ſafe and pleaſant to the operator. It may be ſuppoſed much of the gaz muſt be waſted in the lixivium: if put in injudiciouſly it will, but, if in a proper quantity, the ſame charge will bleach much more effectually than without it; being ſo volatile that it is difficult to confine it. I have ſeen the finer and more ſubtile parts penetrate through the neck of a ſtone retort of conſiderable thickneſs, which is ſoon rendered porous by repeated uſe; and, as ſoon as the caſe was opened, great quantities would fly off, and, if the people employed did not fly from it for a time, they would experience a

trembling

trembling of the limbs, ſick head-ach, painful ſenſation at the ſtomach and throat, and a wheeſing cough, as if afflicted with a violent aſthma; all of which are removed by the application of the lixivium. As the gaz decompoſes all the ſubſtances found in the pores of wood, to the deſtruction of the wood, and continual decreaſe of the bleaching power, it will be neceſſary to line the caſe with ſome kind of cement that will repel it: I have lined my box or caſe with a thick coat of white paint, which hath anſwered tolerably well. When I have thus prepared my box or caſe with the lixivium and falſe bottom, I fill it with the article to bleach; having cloſed the cover, I fix the retort with the chemical mixtures heretofore mentioned. The preciſe charge to each of theſe retorts cannot be affixed, but muſt be regulated by the article to be bleached, which the judgement and ingenuity of the operator muſt determine; for inſtance, that charge which might with ſafety be employed on a ſtrong coarſe rag would injure the texture of a fine or tender one; and that charge which would be ſufficient

for a fine rag would be ineffectual for a very coarſe one. A few careful experiments will furniſh a diligent perſon with more inſtructions and knowledge on thoſe particulars than all that can be written; I have however generally found, that leſs than two pounds weight of vitriolic acid, to each hundred weight of rag or pulp, hath been inſufficient for the fineſt, and that more than five pounds weight was miſchievous to the coarſeſt, having a tendency to take out ſtrength as well as colour. The heat communicated to theſe retorts is by boiling water, as before mentioned, being neither accompanied with the dirt, the expence, or labour, of ſand-heats, and much more uniform in its effects. Many circumſtances may happen to make ſeparate caſes and fire produce different ſhades, therefore, inſtead of many caſes, I intend having only one, equal in dimenſions to all I propoſe bleaching at a time; with retorts in proportion; with a trough of ſome convenient ſubſtance, to hold the body of the retorts in boiling water; and with a cover to confine in the ſteam; by which means the heat will be retained, and the cold

cold air kept from checking the aſcent of the gaz when it becomes weak. A caſe of about twelve feet long, three feet deep, and twenty-eight inches wide, with about four retorts, would bleach from ſix to eight hundred weight at a time. After the article hath been expoſed to the action of the gaz for eight or ten hours, it may be taken out of the caſes; and, if entirely freed from ſheaves, it may be made into paper; but, if any ſheaves remain, it muſt be again ſubmitted to a ſecond maceration, or boiling, and made into paper; then finiſhed from the packs in the water-leaf or ſheet, as before particularized. In witneſs whereof, &c.

XLIV. *Specification of the Patent granted to Mr.* James Stuard, *of the Pariſh of St. Anne, Middleſex; for his invention of an Anchor on a new Conſtruction, for Ships and Veſſels, which is much ſuperior to thoſe now in uſe.*

WITH A PLATE.

Dated Feb. 4, 1796.

TO all to whom theſe preſents ſhall come, &c. Now know ye, that I the ſaid James Stuard, in compliance with the ſaid proviſo, do hereby deſcribe and aſcertain the nature of my ſaid invention, and declare that the ſame is to be performed in manner following: that is to ſay; whereas, the uppermoſt fluke of a common anchor, which has two, is dangerous to ſhips and veſſels which may happen to ground by it, and alſo frequently occaſions the anchor to be tripped, by the cable taking hold of it on the ſhip's ſwinging, to the hazard

hazard of the ſhip's going on ſhore, or occaſioning damage, by driving foul of other ſhips or veſſels. To obviate ſuch conſequences I would have but one fluke; and, that the anchor may be ſure to fall the right way, with the fluke downward, I would have the ſhank very ſhort; whereby, when ſuſpended by the cable, it will cant the moſt, and when it has hold in the ground the ſhip will ride ſafer; as a long ſhank has more power to looſen and break the ground, and is more likely to be bent or broken from its hold. The form of the ſhank and arm of the anchor to be as AA, Fig. 1. (Plate XXII.) in the annexed drawing; and, that they may be ſtronger than if made ſeparately and ſhot together, I would have the bars which compoſe them in one length; ſo that there be no ſhoot or joining in the whole length of the ſhank and arm. The hole B is to receive the ring for the cable, and the hole C for the ſtock. Or, the ſhank may be made without the hole C, and the hole B made octagonal; or, if round, I would have a ſmall projection on the ſtock, and a ſmall cavity on one ſide of the hole B to receive it, to prevent the ſhank's turning; and, inſtead of a ring for the cable, to have a ſhackle,

ſhackle, through which, and the ſhank at B, the ſtock muſt paſs; and, that the ſhackle may not fall too low, have a ſtop on each ſide, at the upper end of the ſhank. The palm to be in ſhape as D D, Fig. 1. and as Fig. 2. made either entirely of caſt iron, or a caſt-iron ſhell filled with lead; that being of much more ſpecific gravity than iron. The back of the palm to be formed either as the convex lines, or the ſtrait lines making angles at the centre, or the concave lines. The ſtock to be compoſed of a wrought-iron bolt, as A, Fig. 3. covered with caſt iron, B B. Alſo to have a ſmall ſhackle, or two plates with a ſmall bolt between them, as E E, Fig. 1. on the bend of the ſhank and arm, for the buoy-rope to be made faſt to; or a long circular bolt paſſed through the plates, and faſtened to each corner of the palm. In witneſs whereof, &c.

Fig 1

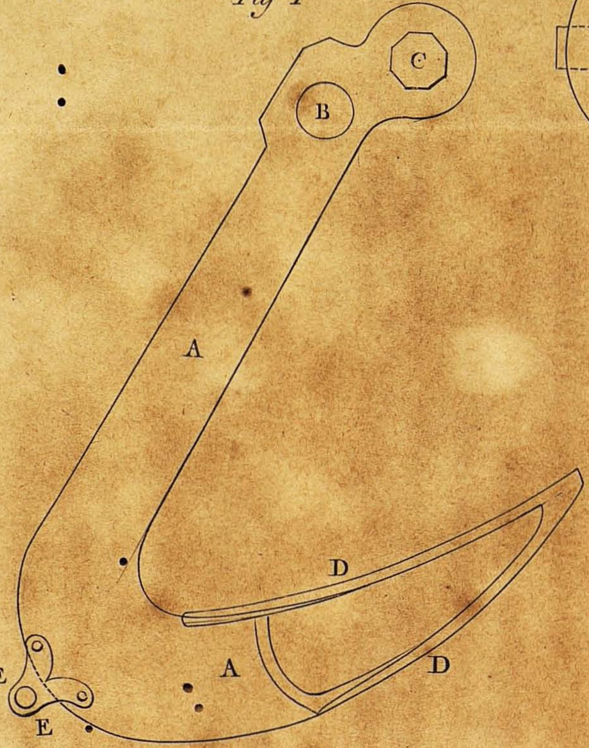


Fig 3

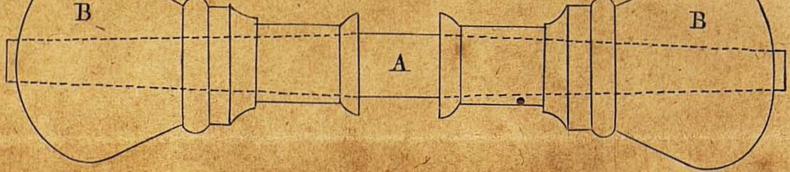
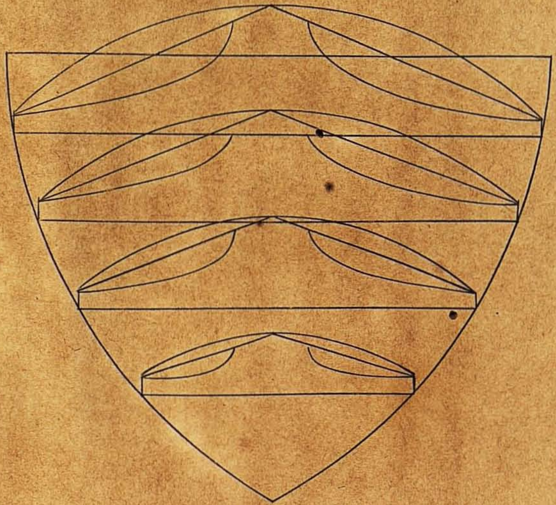


Fig 2



XLV. *Specification of the Patent granted to Mr.* Jaçob Levy, *of Garden-court, in the Pariſh of St. Botolph, Aldgate; for his Invention of the Art of making Semolina from Wheat.*

Dated July 5, 1780.—Term expired.

To all to whom theſe preſents ſhall come, &c. Now know ye that, in compliance with the ſaid proviſo, I the ſaid Jacob Levy do hereby declare, that my ſaid invention of the art of making from wheat, the growth of this kingdom, ſemolina, from which vermicelli and macaroni are manufactured, equal in quality and goodneſs to that imported from Italy, is deſcribed in manner following: that is to ſay; the wheat is ground in a flour-mill, and the flour ſeparated from the middlings; the ſaid middlings are dreſſed in a bolting-mill, in four different ſorts, and then ſifted through parchment ſieves, till all the bran and pollard is ſeparated from them. In witneſs whereof, &c.

XLVI. *Obſervations on the raiſing and dreſſing of Hemp.* By EDWARD ANTILL, *Eſq.*

From the TRANSACTIONS of the AMERICAN PHILOSOPHICAL SOCIETY.

WHOEVER would raiſe hemp properly, and to advantage, ſhould ſet aſide two pieces of ground, of ſuch dimenſions each as he ſhall be able to cultivate every year, and ſow the one, while he is manuring and preparing the other for the ſucceeding year's crop; the higher and drier the ground the better, provided it be well dunged, and made ſtrong and mellow. The ground ſhould not be too ſloping, leſt the good ſoil be waſhed away with hard rains; if it droops toward the South, ſo that it may have the full influence of the ſun, it will be an advantage; low, rich, warm, dry grounds will alſo produce good hemp; but wet land, though ever ſo rich, will by no means do. The ground being prepared, and made very

very mellow, I now come to that part which muſt be particularly and exactly attended to, ſince the ſucceſs of the crop greatly depends upon it. Some time in May, the ground, being moiſt and in a vegetating ſtate, but by no means wet, muſt be well ploughed, the furrows muſt be cloſe and even, and the ſoil muſt lie light and mellow; it muſt then be ſown very even, with two buſhels of ſeed upon one acre. A man with an iron-tooth harrow follows the ſower, and harrows in the ſeed, with two horſes, without any balks; for, the leſs the ground is trampled the better. If harrowing one way be not ſufficient to cover the ſeed, though it would be beſt if that could be done, it muſt be croſs-harrowed. The ground being moiſt, as I ſaid before, but by no means ſo wet as to clod, which would ruin the crop, the ſeed will all ſtart and come up together, which is a ſure ſign of a good crop, and nothing after that, but too much wet, will hurt it; for, hemp thus come up bids defiance to weeds and graſs of every kind. Its growth is ſo quick, and it ſo effectually ſhades the ground, that nothing below can riſe, or ſhew its head; and it ſo preſerves all the moiſture below, that, the

 hot-

hotter and drier the weather, the faſter it grows. Whereas, if the ſeed be grown when the ground is dry, the ſeed that lies deepeſt, where the moiſture is, will come up firſt, and theſe plants will ſhade and ſtarve thoſe that come up after; by which means the firſt comers will be too large, and the laſt will be much too ſmall, ſo that the crop will be greatly damaged every way: ſo much depends upon this one circumſtance, of ſowing the ſeed when the ground is moiſt, and fit to receive it. The crop, thus rightly managed, will ſtand as thick as very good wheat, and be from four to ſix feet high, according to the ſtrength of the ground, and the ſtems will not be thicker than a good wheat ſtraw; by this means the hemp will be finer, it will yield the greater quantity, and it may be plucked from the ground, like flax, which will be a great ſaving. But, if it be ſown thin, that is, one buſhel to an acre, which is the common practice, it grows large; the hemp is harſh and coarſe, and then it muſt be cut with hooks, which occaſions great waſte; for, four or five inches above the ground is left by way

of

of ſtubble, which contains the beſt and heavieſt part of the hemp.

When the hemp has got its growth, and is fit to be plucked, which you will know by the under leaves of the carle or male hemp turning yellow and falling off, the ſooner it is pulled the better. It muſt then be bound up with ſtraw bands, in ſingle-band ſheaves, rather ſmall than large, and each ſheaf muſt be bound in two places; and, the ſooner it is carried to the water, to rot, the better. Water-rotted hemp, if it be rightly managed, is every way better than that which is rotted on the ground; there is leſs waſte in it, when it comes to be dreſſed; it looks brighter and fairer to the eye; it is eſteemed to be ſtronger and more durable, and it always fetches a better price; beſides, it is much ſooner done, and it is rotted more even and alike, and with greater certainty and exactneſs. Many people in America are acquainted with the method of rotting hemp in water; but, as many more are not yet acquainted with it, I ſhall, for their information, ſet down the method of doing it. Hemp may be

rotted in ſtagnated or ſtanding water, ſuch as ponds, pools, or broad deep ditches; and, in ſuch water, it is generally four or five days and nights in rotting, and ſometimes longer, according to the heat or coolneſs of the weather. It may alſo be rotted in running water, as in a brook or river; and, in ſuch water, three or four days and nights are ſufficient, according to the weather. To know whether the hemp is rotted enough, in either caſe, take a middling handful out of the middle row, and try with both your hands to ſnap it aſunder; if it break eaſy, it is rotted enough; but, if it yet appear pretty ſtrong, it is not, and muſt lie longer, till it breaks with eaſe; then it muſt be taken out, and dried as ſoon as poſſible. In handling the ſheaves, take hold of the bands, and ſet them upright againſt a fence, if one be near, or lay them down upon the graſs, for the water to drain off; then unbind them carefully, open and ſpread them, that they may dry thoroughly; then bind them up again, and houſe them in a dry tight place. The reaſon of handling the hemp in this careful manner is, that, when it is well rotted, whilſt it is wet the lint

comes

comes off with the leaſt touch; therefore, if it be handled roughly, or if, while it is wet, it be thrown into a cart, and carried to a diſtance to be unbound and dried, it will be greatly hurt, and the owner will receive great damage; but, when it is dry, it may be handled with ſafety.

If the hemp be rotted in a brook or running water, the ſheaves muſt be laid acroſs the ſtream; for, if they be laid down lengthways with the ſtream, the current of the water will waſh away the lint, and ruin the hemp: it muſt be laid down heads and points, two, four, or ſix thick, according to the depth of the water, and the quantity of hemp. If the bottom of the river be ſand, gravel, or mud, three good ſtrong ſtakes muſt be driven down at each end, above and below, and three long ſtrong poles muſt be laid on the hemp, and faſtened well to the ſtakes, in ſuch manner as to force down the hemp under water, where it is to remain till it is rotted enough; though, if a muddy ſtream could be avoided, it would be beſt, becauſe it is apt to foul and ſtain the hemp. If the bottom of the ſtream be rocky or ſtony, ſo that ſtakes cannot be driven down to ſecure the

hemp

hemp under water, and prevent its floating away, then a rough wall muſt be made at the lower end of the hemp, and along the ſide, to keep it in; and ſtrong poles or rails muſt be laid upon the top of the hemp, and pretty heavy ſtones upon them, ſo as to ſink the hemp under water, where it muſt lie till it is rotted enough.

What hemp is intended for ſeed, ſhould be ſown on a piece of ground by itſelf, which muſt be made very rich and ſtrong. It muſt be ſown in ridges ſix feet wide; and the ſeed muſt be of the largeſt and beſt ſort, and ſown very thin, at the rate of a peck upon an acre, or rather ſix quarts; for, the thinner it is ſown the more it branches, and the more ſeed it bears. It ſhould be ſown ſome time about the middle of April, and then the ſeed will not be ripe till ſome time after the other hemp is done with. If you have no convenient place to ſow your ſeed-hemp by itſelf, then ſow a border, of ſix feet wide, along the North and Weſt ſides of your hemp-field. The reaſon for ſowing your ſeed-hemp in ſuch narrow ridges or borders is, that when the carle or male hemp is ripe, and has ſhed its farina on the fimble or female hemp,

hemp, (by which the ſeed is impregnated,) and the leaves of the carle hemp fall off, and the ſtem grows yellow, you may eaſily ſtep in along the ſides, and pull up the carle without hurting the female, which now begins to branch out, and looks of a deep green colour, and very flouriſhing; and, when the ſeeds begin to ripen, which is known by their falling out of their ſockets, you may, all along both ſides, bend down the plants, and ſhake out the ſeed upon a cloth laid on the ground; for, as they ripen, they ſcatter upon being ſhaken by a hard wind, or otherwiſe. Then it muſt be watched, and the fowls and yellow-birds kept from it, for they are immoderately fond of the ſeed. As the firſt ripe ſeeds are the fulleſt and beſt, they are worthy of ſome pains to ſave them; and the beſt way to do that is, to bend down the plants all along, on each ſide of the border or ridge, as is ſaid above, and ſhake them over a cloth ſpread on the ground to receive the ſeed. If one ſide of the plant be rooted out of the ground, by forcing it down to ſhake out the ſeed, there will be no damage, the ſeed that remains will ripen notwithſtanding; and the plant

muſt

muſt be thus ſhaken every two or three days, till all the ſeeds are ripe, and thus ſaved. This way is much better than pulling up the plants by the roots, and ſhaking them on a barn-floor, and then ſetting them up againſt a fence on the ſide of the barn, for the ſeed to ripen, ſhaking them again morning and evening on the barn-floor; for, by this method, which is the common practice, one third of the ſeed at leaſt never comes to maturity.

It is well known to every farmer, that, in the three bread-colonies at leaſt, the ſpring and ſummer ſeaſons are of late years become very dry; ſo that a crop of flax is become very precarious, ſcarcely one year in ſeven producing a good one. This is a conſtant complaint in the mouth of every huſbandman: now, hemp does not require half the rain that flax does; this is a circumſtance that is well worth the notice and attention of every farmer; and therefore, by his raiſing hemp in the manner before directed, and by preparing it in the beſt manner for ſpinning and weaving into good cloth, he can with greater certainty ſupply all the neceſſary uſes of his family; and, by ſelling

ling the overplus, he can purchaſe ſuch things as his wife and daughters may think convenient on extraordinary occaſions. This, however, need not hinder him from raiſing ſome flax every year: but I think that it is more for his intereſt to fix his chief dependence upon his crop of hemp, as that is more ſure, and every way more profitable, the general run of ſeaſons conſidered.

I ſhall now endeavour to inſtruct the huſbandman in a few eaſy rules for preparing his hemp, which he has raiſed and managed in the manner before directed.

The beſt preparation of hemp, for the manufacturing of cloth, is to render it as ſoft and as fine as poſſible, without leſſening its ſtrength; and the eaſieſt and cheapeſt way of doing this is certainly the beſt. This is to be found out by a variety of trials and experiments; but, till a better way is diſcovered, with which I ſhould be greatly pleaſed, take the following method, which is the beſt I have yet been able to diſcover.

If you have a large wide kettle, that will take in your hemp at full length, it will be the better; but, if your kettle be ſmall, then you muſt

double your hemp, but without twiſting; only the ſmall ends of every hand muſt be twiſted a little, to keep them whole and from entangling. Then, firſt of all, lay ſome ſmooth ſticks at the bottom of the kettle, ſo as to lie acroſs one another, three or four layers, according to the ſize and depth of your kettle: this is to keep the hemp from touching the liquor. Then pour ſome ley of middling ſtrength, half as ſtrong as what you make ſoap of, gently into the kettle, not ſo much as to riſe up to the top of the ſticks, they being kept down to the bottom. Then lay in the hemp, each layer croſſing the other, ſo that the ſteam may riſe up through the whole body of hemp; which done, cover your kettle as cloſe as you can, and hang it over a very gentle fire, and keep it ſimmering or ſtewing, but not boiling, ſo as to raiſe a good ſteam for ſix or eight hours. Then take it off, and let it ſtand covered till it is cool enough to handle. Then take out the hemp, and wring it very carefully, as dry as you well can, and hang it up out of the way of the wind, either in your garret or your barn, ſhutting the doors; there let it remain, turning it now and then, till

till it is perfectly dry. Then pack it up in ſome cloſe dry place till you want to uſe it; but you will do well to viſit it now and then, leſt any part might be damp and rot. You muſt know that wind and air weaken and rot hemp, flax, and thread, very much. Then, at your leiſure, twiſt up ſome of the hands, as many as you intend for preſent uſe, as hard as you can, and, with a round ſmooth hand-beetle, on a ſmooth ſtone, beat and pound each hand by itſelf all over very well, turning it round from ſide to ſide, till every part be very well bruiſed. You muſt then untwiſt it, and hatchel it, firſt through a coarſe, and then through a fine hatchel; and remember, that hatcheling muſt be performed in the ſame manner as a man would comb a fine head of hair; he begins at the end below, and, as that diſentangles, he riſes higher, till at laſt he reaches up to the crown of head. The firſt tow makes good ropes for the uſe of the plantation; the ſecond tow makes very good coarſe ſheeting; and the hemp itſelf will make excellent linen. The ſame method of ſteaming ſoftens flax very much.

XLVII. *Conclusion of Mr.* KIRWAN'S *Experiments on the alkaline Substances used in bleaching, &c.*

(FROM P. 349.)

I TRIED also another sort of ashes, which I had from a chandler; they were of a whiter colour, and cleaner. The solution of an ounce of them, in six ounces of water, precipitated only 5,5 grains of earth of alum, and therefore contained but 8 grains of mere alkali.

There is a remarkable circumstance attending these ashes, namely, that if they be much calcined they seem to lose their alkaline properties, and the solution no longer precipitates that of corrosive sublimate reddish, as alkalies not thoroughly aërated do. What this circumstance depends on, I have not as yet examined, but am almost certain it proceeds from the presence of common salt, as fixed alkalies and common salt melt very easily, and thus unite to the earths.

To

To eſtimate the goodneſs of different aſhes, ſome have recommended the uſe of an hydrometer, whereby to diſcover the ſtrength of ſolutions of equal weights of theſe aſhes in equal quantities of water; but, as this inſtrument is equally affected by the preſence of neutral ſalts as of alkali, it becomes uſeleſs.

Table of the Quantity of mere Alkali in one hundred avoirdupois Pounds of the following Subſtances, by the aluminous Teſt.

One hundred Pounds,	Mineral Alkali.
Cryſtalized ſoda, - -	20 lbs.
Sweet barilha, - -	24
Mealy's Cunnamara kelp, -	3,457
Ditto deſulphurated by fixed air,	4,457
Strangford kelp, - -	1,25

One hundred Pounds,	Vegetable Alkali.
Dantzic pearl-aſh, - -	63,33 lbs.
Clarke's refined aſh, -	26,875
Caſhup, - - -	19,376
Common raw Iriſh weed-aſh, -	1,666
Ditto ſlightly calcined, -	4,666

SEC-

SECTION VI.

Of the beſt Manner of procuring alkaline Salts.

Of the Method of procuring mineral Alkali. Firſt. Mineral alkali may be procured more or leſs pure from the combuſtion of the various ſpecies of kali, or *Salſola* of Linnæus, or from that of the different ſpecies of *Salicornia* and *Chœnopodium* of the ſame author. The compounds thus formed are called *barilhas* or *ſoudes*.

The cultivation of the *Salicornia* may be ſeen in the fifth volume of the *Mémoires des Savants étrangers*. A French acre (1,261 Engliſh) produces one ton of this weed; and this ton, when burned, produces but 100 weight of barilha, and this of a kind inferior to ſweet barilha. A ſmall quantity of this alkali is alſo contained in kelp. I am inclined to think that much of the alkali is loſt by its union with the earthy parts, during the fuſion effected in the common manner of fabricating this ſubſtance; and therefore the proceſs ſuggeſted

gested by M. Cadet may be useful. He advises a trench, two feet deep, seven feet long, and eighteen inches broad, to be made, lined with clay mixed with sand, and over this, iron bars, two inches distant from each other, to be laid; upon which a wall 2,5 feet high is to be constructed, of limestone, if possible; over the bars the dry sea-weed is to be laid, and set fire to; the ashes will fall into the trench, and when it is full the fire is discontinued *. I believe also that washing the sea-weed in fresh water, to carry off the sea-salt that adheres to it, would be useful.

To desulphurate kelp, the Abbé Mazeas recommends projecting on it, while in a red heat, $\frac{1}{3}$ of its weight of nitre; but this process seems too expensive to be practised in the great.

Secondly. This alkali is found native in Egypt, and in several parts of the Russian empire, and perhaps may be cheaply imported.

Thirdly. Common salt may be decomposed, after Mr. Turner's method, by trituration with

* Mémoires de l'Académie des Sciences de Paris, 1767.

litharge. As the calx of lead here employed is afterwards converted into a yellow pigment, this method is very beneficial.

I have alſo contrived another proceſs for decompoſing common ſalt. The particulars of my experiment were as follow.

Firſt. I rendered the common ſalt pure, by adding to its ſolution a ſolution of mineral alkali, until all the earthy matter was depoſited.

Secondly. To a ſolution of three ounces of this purified ſalt, in nine ounces of water, I gradually added a ſaturate ſolution of 4,75 ounces of ſugar of lead, both hot, until the ſolution of lead ſcarcely excited any whiteneſs in that of the common ſalt. After one night's reſt, part of the ſugar of lead cryſtalized in the bottom of the veſſel; by which it is plain that too much of it had been uſed; theſe cryſtals weighed 240 grains. The ſupernatant liquor I again evaporated to nearly $\frac{2}{3}$, and after two days obtained large pellicles of acetous ſoda, which I ſeparated: they weighed 325 grains. To the reſiduum, which ſtill had a ſweetiſh taſte, I added a ſolution of mineral alkali, until no farther

ther precipitation appeared; a very ſmall quantity of the alkali was ſufficient for this purpoſe. I then evaporated the remainder nearly to dryneſs, and afterwards heated it in a crucible to redneſs. In this heat it inflamed, and, when calcined nearly to whiteneſs, I took it out, diſſolved it in twelve ounces of water, filtered it, and, on adding a hot ſolution of alum, obtained a precipitate which, when dried, weighed 169 grains, and indicated the quantity of pure alkali to be 112 grains nearly. In this proceſs nothing is loſt, for the lead may be either revived or turned into a pigment.

Laſtly. Glauber's ſalt may afford the mineral alkali, but moſt eaſily in the form of liver of ſulphur: I endeavoured to decompoſe it by the above proceſs, but the quantity of alkali obtained from a large quantity of it was very inconſiderable.

Of the vegetable alkali. It is univerſally known that this alkali may be extracted, in a greater or leſs quantity, by lixiviation, from the aſhes of almoſt all vegetables; and it is *now* well eſtabliſh-

ed that it pre-exiſts in vegetables before combuſtion; not indeed in a ſeparate uncombined ſtate, but united partly with the vitriolic or marine acids, and ſometimes the nitrous, but generally, and for the greater part, with a vegetable acid, or oil, with which it forms eſſential ſalts, as they are termed. Theſe vegetable acids and oils are decompoſed during combuſtion, and thus the alkaline part is ſet free; but the vitriolic acid, by contact with inflamed matter, is converted into ſulphur; part of which unites to the free alkali, which protects it from combuſtion, and thus forms what is called *liver of ſulphur*; a product found in moſt aſhes, eſpecially when the air has not had free acceſs to them during combuſtion.

As alkaline ſalts are of great importance in ſeveral arts, the proportion of aſhes afforded by different vegetables, and that of alkali by the aſhes of each ſort of vegetable, has of late been accurately attended to: I ſhall here preſent the beſt authenticated reſults of the experiments made with this view.

One

One thousand pounds of the following vegetables, perfectly dry, and burned in a clean chimney and open fire, afforded the quantity of ashes, and saline matter, exhibited in the annexed tables.

One thousand Pounds.	Pounds of Ashes.	Pounds of Salt.	
Stalks of Turkey-wheat or maize, -	88,6	17,5	
Ditto of sunflower,	57,2	20	
Vine branches, -	34	5,5	
Box, - -	29	2,26	
Sallow, - -	28	2,85	
Elm, - -	23,5	3,9	
Oak, - -	13,5	1,5	
Aspin, - -	12,2	0,74	
Beech, - -	5,8	1,27	
Fir, - -	3,4	0,45	
Fern cut in August,	36,46	4,25	Home.
Wormwood, -	97,44	73	Wiegleb.
Fumitory, -	219	79	Id.

Table of the ſaline Products from one thouſand Pounds of the Aſhes of the following Vegetables.

	Saline Products.
Stalks of Turkey wheat or maize, -	198 lbs.
Ditto of ſunflower,	349
Vine branches, -	162,6
Elm, - -	166
Box, - -	78
Sallow, - -	102
Oak, - -	111
Aſpin, - -	61
Beech, - -	219
Fir, - -	132
Fern cut in Auguſt,	116, or 125 according to Wildenheim.
Wormwood, -	748
Fumitory, -	360
Heath, - -	115 Wildenheim.

Hence we ſee that, in general, weeds yield much more aſhes, and their aſhes much more ſalt, than woods; and that conſequently, as to ſalts

ſalts of the vegetable alkali kind, ſuch as pot-aſh, pearl-aſh, caſhup, &c. neither America, Trieſte, nor the northern countries, poſſeſs any advantage over us.

Secondly; that, of all weeds, fumitory produces moſt ſalt, and next to it wormwood; but, if we attend only to the quantity of ſalt in a given weight of aſhes, the aſhes of wormwood contain moſt. *Trifolium fibrinum* (Buck-bean) alſo produces more aſhes and ſalt than fern.

Moſt of the experiments on woods were made in France, by order of government, under the inſpection of the overſeers of the ſaltpetre-works; yet are to be read with caution by thoſe that attend to the quantity of alkali with reſpect to bleachers; for, as vitriolated tartar (a ſalt uſeleſs to bleachers) is as ſerviceable to the makers of ſaltpetre as alkaline ſalts, they have conſtantly confounded one with the other; but the experiments made on weeds were inſtituted by perſons who carefully diſcriminated theſe ſalts. 100 grains of the ſalt of wormwood contain but ſix of vitriolated tartar, and 100 grains of the ſalt of fumitory contain 15. All alkaline ſalts, unleſs mixed with lime,

lime, contain alſo $\frac{1}{5}$ at leaſt of fixed air; which produces no other effect in bleaching than that of reſtraining their activity.

SECTION VII.

Of the Proceſs of obtaining Pot and Pearl Aſh.

Firſt. The weeds ſhould be cut juſt before they ſeed; then ſpread, well dried, and gathered clean.

Secondly. They ſhould be burned within doors on a grate, and the aſhes laid in a cheſt as faſt as they are produced. If any charcoal be viſible, it ſhould be picked out, and thrown back into the fire. If the weeds are moiſt, much coal will be found. A cloſe ſmothered fire, which has been recommended by ſome, is very prejudicial.

Thirdly. They ſhould be lixiviated with twelve times their weight of boiling water. A drop of the ſolution of corroſive ſublimate will immediately diſcover when the water ceaſes to take up any more alkali. The earthy matter that remains is ſaid to be a good manure for clayey grounds.

Fourthly.

Fourthly. The ley thus formed ſhould be evaporated to dryneſs in iron pans, two or three at leaſt of theſe ſhould be uſed, and the ley, as faſt as it is concentrated, paſſed from one to the other: thus, much time is ſaved, as weak leys evaporate more quickly than the ſtronger. The ſalt thus procured is of a dark colour, and contains much extractive matter; and, being formed in iron pots, is called *pot-aſh*.

Fifthly. This ſalt ſhould then be carried to a reverberatory furnace, in which the extractive matter is burned off, and much of the water diſſipated; hence it generally loſes from 10 to 15 *per cent*. of its weight. Particular care ſhould be taken that it do not melt, as the extractive matter would not be thoroughly conſumed, and the alkali would form ſuch an union with the earthy parts as could not eaſily be diſſolved. I add this caution, as Dr. Lewis and Mr. Doſſie have inadvertently directed the contrary. This ſalt, thus refined, is called pearl-aſh, and muſt be the ſame as Dantzic pearl-aſh *.

* The French call the refined aſh *potaſſe*, and the unrefined *ſalin*.

For

For the moſt œconomical conſtruction of a laboratory and furnaces for the above operations, I refer to the deſcription given in a French tract, called *L'Art de fabriquer le Salin & la Potaſſe*; and ſhall only add, that if the ſalt were extracted by a fire ſupported by vegetables, whoſe aſhes might afterwards be employed, no inconſiderable advantage would be gained. Pearl-aſh is frequently tinged green, or blue; this colour it acquires during fuſion, not from any union of the ſalt with phlogiſton, as was formerly ſuppoſed, but by reaſon of the manganeſe contained in the aſhes of almoſt all vegetables, as Mr. Scheele has ſhewn. When it is calcined without melting, it is as perfectly white as Dantzic pearl-aſh.

SECTION VIII.

Of the colouring Matter of linen Yarn, and its Solvents.

Having, through the obliging attention of Mr. Arbuthnot, procured a ſufficient quantity of alkaline ley ſaturated with this colouring-matter, or, as the workmen call it, *killed*, and which they are

in

in the habit of throwing away, I found it to be a turbid liquor, of a reddiſh brown colour, a peculiar taſte, and ſtrong ſmell, affording no ſign either of acidity or alkaleſcence. On five quarts of this liquor, I poured two ounces of weak marine acid; there was no effervеſcence, but a copious depoſition inſtantly took place, of a greyiſh green colour, and the liquor freed from this depoſit was of the colour of red amber.

The next day I drew off the liquor with a ſyphon, and poured two quarts of pure water on the depoſited matter, and, having agitated the whole, ſuffered this matter again to ſubſide, drew off the water, and added two quarts more; this liquor gave manifeſt ſigns of acidity, and continued ſomewhat reddiſh. Preſuming that, after the addition of ſo much water, this acidity could not proceed from the ſmall quantity of marine acid I had uſed, more eſpecially as the liquor originally contained an alkali, in the ſaturation of which the greater part of the acid muſt have been employed, I began to ſuſpect that this ley contained an acid of its own, which was diſengaged and ſeparated from the alkali by the marine acid, as the

more powerful of the two; and hence I reſerved the two quarts of liquor laſt added, for ſubſequent experiments.

After repeated effuſions of cold water, when the characters of acidity were ſcarcely any longer perceptible, I threw the depoſited matter on a filter, and ſuffered it to dry for ſome time; it was then of a dark greeniſh colour, and ſomewhat clammy, like moiſt clay. I took a ſmall portion of it, and added to it ſixty times its weight of boiling water, but not a particle of it was diſſolved. The remainder I dried in a ſand heat; it then aſſumed a ſhining black colour, became more brittle, but internally remained of a greeniſh yellow, and weighed $1\frac{1}{2}$ ounce.

By treating eight quarts more of the ſaturated ley in the ſame manner, I obtained a farther quantity of the greeniſh depoſit; on which I made the following experiments.

Firſt. Having digeſted a portion of it in rectified ſpirit of wine, it communicated to it a reddiſh hue, and was in a great meaſure diſſolved; but, by the affuſion of diſtilled water, the ſolution became milky, and a white depoſit was gradually formed:

formed: the black matter diffolved in the fame manner.

Secondly. Neither the green nor the black matter was foluble in oil of turpentine, or linfeed oil, by a long continued digeftion.

Thirdly. The black matter, being placed on a red-hot iron, burned with a yellow flame and a black fmoke, leaving a coaly refiduum.

Fourthly. The green matter, being put into the vitriolic, marine, and nitrous acids, communicated a brownifh tinge to the two former, and a greenifh to the latter, but did not feem in the leaft diminifhed.

Hence it appears, that the matter extracted by alkalies from linen-yarn is a peculiar fort of *refin*, different from pure refins only by its infolubility in effential oils, and in this refpect refembling lacs. I now proceeded to examine the power of the different alkalies on this fubftance. 8 grains of it being digefted in a folution of cryftallized mineral alkali, faturated in the temperature of 60°, inftantly communicated to the folution a dark brown colour: two meafures (each of which would contain eleven penny-weights of water)

 did

did not intirely diſſolve this ſubſtance. Two meaſures of the mild vegetable alkali diſſolved the whole.

One meaſure of cauſtic mineral alkali, whoſe ſpecific gravity was 1,053, diſſolved nearly the whole, leaving only a white reſiduum.

One meaſure of cauſtic vegetable alkali, whoſe ſpecific gravity was 1,039, diſſolved the whole.

One meaſure of liver of ſulphur, whoſe ſpecific gravity was 1,170, diſſolved the whole.

One meaſure of cauſtic volatile alkali diſſolved alſo a portion of this matter.

Though theſe experiments were fully ſufficient to reſolve my own doubts, yet, to render ſtill more ſatisfaction to bleachers, I repeated them with the ſalts they generally uſe, and alſo with ſoap.

I therefore diſſolved one ounce of ſweet barilha, Dantzic pearl-aſh, Cunnamara kelp, caſhup, and Clarke's pearl-aſh, each in ſix ounces of pure water; and putting, in one ounce-meaſure of each ſolution, 8 grains of the green colouring-matter, ſet them to digeſt in a heat of

about

about 180°, for $3\frac{1}{2}$ hours. At the end of this time I found that

The Dantzic ſalt diſſolved more than the barilha.

The kelp as much as the Dantzic ſalt.

The caſhup, and Clarke's aſh, diſſolved the whole.

Hence, I added half an ounce more of the ſolutions of Dantzic ſalt, barilha, and kelp; the Dantzic ſalt, and the kelp, then diſſolved the whole; but, of the ſolution of barilha, two ounces were requiſite to perform this effect.

I alſo diſſolved half an ounce of Windſor ſoap in eighteen ounces of water. The ſolution was turbid, and could not be rendered tranſparent, except when it was near boiling, and then it was very unmanageable; for, when boiled, it ſpouted three feet high out of the bottle. Three ounces of this ſolution were requiſite to diſſolve eight grains of the colouring-matter.

Now, to compare the powers of theſe different ſolvents, we muſt remark, that as an ounce of barilha contains 115 grains of mere alkali, the ſolution of it being made in ſix ounces of water, each

each ounce of the ſolution muſt contain the ſixth part of 115, that is 19 grains; and, in the ſame manner it will be found, that an ounce of the ſolution of Dantzic ſalt contains 50 grains of mere alkali; that of Cunnamara kelp 2,8 grains; that of caſhup 15; and that of Clarke's aſh 21.

Therefore 4,2 grains of ſaline ſubſtance of kelp performed the ſame effect,

As 75 of that of Dantzic ſalt,
38 of that of barilha,
15 of that of caſhup,
21 of that of Clarke's aſh,
213 of ſoap.

I alſo tried the power of lime-water, but found that three ounces of the ſtrongeſt diſſolved very little of the colouring-matter, as ſhould be naturally expected; for, the three ounces did not contain above three grains of lime, nor did the mixture of ſulphur render it more active.

From the foregoing experiments we may now deduce the following practical propoſitions.

Firſt. Liver of ſulphur is, of all alkaline compounds, the ſtrongeſt ſolvent of the colouring-matter; next to this the cauſtic vegetable, and after this

this the caustic mineral alkali; the mild vegetable, and the mild mineral alkali occupy the last place. Sulphur, it is said, leaves a stain in linen; but, if liver of sulphur be used in the beginning, that is to say, in bleaching the yarn, the stain will probably be removed by the purer alkalies afterwards used. Hence, the solutions of kelp, cashup, and markoft, are advantageously used in the first processes of bleaching, for which Dantzic salt and sweet barilha are less fit; but six tons of kelp will be necessary to produce the same effect as one ton of cashup; yet, as the former is manufactured at home, it deserves the preference.

Secondly. As the alkali manufactured from inland weeds is more powerful than the mineral, Mr. Clarke's is more powerful, or may be rendered so, than any imported. It is already sufficiently caustic, and may be converted into liver of sulphur, only by adding $\frac{1}{20}$ of its weight of sulphur to it when boiling; and thus it is fitted for the first processes of bleaching. In its primitive state it is fit for the second process; and, by rendering it milder, which may be effected by burning half a bushel of charcoal in a pan, in the

same

ſame room in which its ſolution ſtands, it will be adapted to the laſt proceſſes, in which a leſs active alkali is required.

Thirdly. Mr. Clarke's ſalt, converted into liver of ſulphur, is preferable to kelp, becauſe this latter, by the preſent manner of manufacturing it, holds charcoal in ſolution; this coaly matter it depoſits on the yarn, and thus leaves a black tinge; whereas Mr. Clarke's is free from this contamination, to ſay nothing of the far greater quantity of alkali it contains, which is ſuch that one ton of it is nearly equal to eight tons of kelp. Hence it clearly follows, that the linen manufacture ſtands in no ſort of need of foreign ſalts or aſhes, for the proceſſes of bleaching.

The chiefeſt defect in Mr. Clarke's manipulation is, the loſs of time during what he calls the *maceration* of aſhes and quick lime; by barely moiſtening them, the ſame effect may be produced, in nine hours, as he expects from their maceration during nine months; and much more lime is uſed than is neceſſary.

Dantzic pearl-aſh contains much more alkali than Clarke's; this muſt proceed from the ſuperior

rior quality of the ashes from which it is extracted. Those I received from Mr. Clarke were exceeding bad; nor do I believe that any crude ashes can be advantageously used in bleaching. But, if some persons, in the different manufacturing countries, would allot a few acres to the culture of wormwood and fumitory, I believe their own advantage, as well as that of the public, would thereby be considerably promoted. An acre will, I suppose, scarcely produce less than four tons of the dry weeds; each ton will afford nearly 200 weight of ashes, and each ton of wormwood-ashes will give nearly 1500 weight of unrefined salt, or 1300 of the refined.

The alkali, manufactured after the manner I have indicated in the seventh section, may not be sufficiently caustic for the earlier operations of bleaching; but, by the addition of half a pound of quick lime to every hundred of the salt, or of ten pounds for every ton, it will be rendered sufficiently sharp. There is no danger that any of the lime will remain in the ley; but, if any should, it will be immediately discovered, and deposited, by the addition of a little of the unmixed ley.

XLVIII. *Enquiry into the comparative Intensity of the Heat produced by the Combustion of Charcoal, and charred Turf.* By M. Sage.

From the Memoirs of the Academy of Sciences of Paris.

Turf reduced into the ſtate of coal, or charred, is capable of maintaining a livelier and ſtronger heat, and one of longer duration, than charcoal. This is ſhewn in the following experiments; but to char the turf, by any means except by diſtillation, is a difficult operation; for, when it is done by ſtifling, as is practiſed in making charcoal, a kind of pyrophorus only is obtained. This pyrophorus is produced by the decompoſition of the ſelenite which is in the turf; the vitriolic acid of which combines with the phlogiſton of the coal, and forms ſulphur; which, being

being united with the earth of the ſelenite, conſtitutes pyrophorus.

When turf is charred in the beſt manner, it always contains a portion of earthy liver of ſulphur, which is decompoſed during the combuſtion of the turf. This decompoſed liver of ſulphur blackens and ruſts copper, tarniſhes ſilver, and ruſts iron; and, at the beginning of the combuſtion, even of the beſt charred turf, there is diſengaged a remarkable hepatic ſmell.

The comparative examination of the intenſity of the heat produced by burning charcoal, and charred turf, proves, that the heat of the latter is nearly in the proportion of three to one.

I had two round furnaces of ſix inches diameter, the fire-place of which was four inches and a half in height, and the aſh-hole four inches. I filled one of theſe furnaces with charcoal, and the other with charred turf; and then kindled them, by putting a live coal upon the top. I let both theſe burn, without ſtirring; and placed over them two ſmall bars of iron, upon which I put two ſaucepans of copper tinned, each of which contained three pints of water: the dia-

meter of the ſaucepans was ſix inches and four lines, their height two inches and nine lines, and their thickneſs one line.

The charcoal-fire cauſed four ſaucepans of water to boil in fifty minutes.

The firſt boiled at the end of		14	minutes.
The ſecond	- -	11	
The third	- -	12	
The fourth	- -	13	

The charcoal burned without any flame, and did not alter the colour of the ſaucepans.

Charred turf, made by ſtifling, at firſt emitted a fetid ſmell, to which ſucceeded a briſk flame, without any ſmell. This turf cauſed eleven ſaucepans of water to boil in one hour and fifty minutes *.

The firſt boiled at the end of		13	minutes.
The ſecond	- -	7	

* Either this or ſome of the following portions of time muſt be wrong; as, when added together, they produce only one hour and forty-three minutes.

The

The third	-	-	6 minutes.
The fourth	-	-	5
The fifth	-	-	6
The ſixth	-	-	7
The ſeventh	-	-	7½
The eighth	-	-	7½
The ninth	-	-	10
The tenth	-	-	15
The eleventh	-	-	19

The charred turf made by diſtillation kindled more ſlowly, and emitted a leſs diſagreeable ſmell; its flame was not ſo briſk. It cauſed eleven ſaucepans of water to boil in two hours, ſix minutes and a half *.

The firſt boiled at the end of			33 minutes.
The ſecond	-	-	12

* Here is another error; the following numbers amount to two hours, ſixteen minutes and a half.

We cannot help alſo remarking, that although the author, in the firſt paragraph, ſpeaks of diſtillation as the beſt way to procure good charred turf, yet, according to his experiments, that which was made by ſtifling was ſuperior, in its power of producing heat, to that made by diſtillation.

The

The third	-	-	8 minutes.
The fourth	-	-	8
The fifth	-	-	$7\frac{1}{2}$
The ſixth	-	-	7
The ſeventh	-	-	7
The eighth	-	-	8
The ninth	-	-	10
The tenth	-	-	15
The eleventh	-	-	21

One pound and a half of charred turf, which ſerved for theſe experiments, was not conſumed in leſs than four hours; it left five ounces of reddiſh aſhes, which contained calcareous earth, ſelenite, argillaceous earth, and a ſmall quantity of liver of ſulphur.

One pound and three ounces of charcoal was conſumed in two hours, and left five drachms of alkaline aſhes.

The charred turf produces more heat than charcoal during its combuſtion, becauſe, as it waſtes leſs, it contributes to the decompoſition of a greater quantity of air; and conſequently the heat it occaſions is greater, and of longer duration.

XLIX.

XLIX. *On the Means of watering Kitchen-Gardens, &c. upon a large Scale. By* M. Sylvestre, *Member of the Academy of Dijon, &c.*

WITH A PLATE.

FROM THE *JOURNAL DE PHYSIQUE.*

THE attention which nature beſtows on the vegetables ſhe produces is ſufficient for the wants of thoſe which grow ſpontaneouſly; but almoſt all the vegetables of our kitchen-gardens are either exotic, or are too tough to ſerve for our food in their natural ſtate; they require the care of the gardener, to enable them to reſiſt the enemies which prey upon them, and to overcome the unfitneſs of the ſoil into which they have been tranſplanted, and become proper for the food of man, or other animals. Tilling the earth, manuring it, and watering it, are the moſt efficacious means of producing theſe effects. The two firſt

firſt of theſe are treated of ſo fully, in various works on agriculture, that I ſhall not ſay any thing reſpecting them. The laſt has been leſs conſidered by theoriſts; and thoſe who have written on that ſubject ſeem to have moved in a narrow circle. The ſmall number of their works preſents always the ſame facts, and the ſame methods; of which they know only three different ones, *viz.* irrigation or watering by trenches; making uſe of a watering-pot; and ſprinkling by means of a bruſh, or ſimilar inſtrument. As the laſt method is only applicable to pots, or boxes of plants, I ſhall not take any farther notice of it; the other two methods are the only ones which merit our attention. It would be difficult to determine when watering by trenches was firſt thought of; we know that the Egyptians, the Greeks, and the Romans made a conſtant uſe of it. It was for them that Archimedes invented the ſcrew which bears his name; it was for them that men who ſeem to have thought nothing of time and expence, but to have conſidered only the durability of their works, conſtructed thoſe immenſe reſervoirs, and thoſe ſurpriſing aqueducts, which never fail

fail to impreſs our minds with wonder and admiration. The Chineſe are the only people who, in our time, have conſidered nature upon ſo large a ſcale as the ancients; and have, in conſequence, interſected their country with canals which carry plenty to every part of it. To their precautions in this reſpect are owing thoſe rice-fields which, without inconvenience, they can increaſe to any extent; while apprehenſions of their being prejudicial to health prevent us from cultivating the uſeful grain they produce.

Many authors have treated profeſſedly of the rules to be followed in making theſe canals for irrigation. Vitruvius was the firſt who did ſo; and, ſince that time, Belidor, Lecke, and M. Bertrand, have given to the public the reſult of their experience. They all agree, that the meadow which is to be watered in this manner muſt be in the neighbourhood of a river, or pond, that can furniſh a ſufficient quantity of water; that it muſt have a declivity of about eight or ten inches in one hundred fathoms; and a canal in the middle, which is to be conſidered as the main ſtream, and is to ſupply the ſmall branches or trenches,

 which

which in ſoft ſoils ſhould be carried to the diſtance of about thirty feet, and in hard ones to the diſtance of about fifty feet. Theſe canals, if made in the beſt manner, ſhould be paved, or lined with clay.

In the Annals of Agriculture for the year 1786, M. Deſmarets mentions a method of watering, which he ſaw practiſed with ſucceſs in Champagne, in a meadow which had a very ſmall degree of inclination, and in the middle of which flowed a pretty large rivulet. Sluices were conſtructed on the rivulet, at from one hundred and fifty to two hundred fathoms diſtance; and by ſtopping the ſtream, it was made to overflow and diſcharge its water ſucceſſively into the ſpace between the ſluices; thus every part of the meadow was watered in a ſhort time. The various methods which are followed with advantage in the Milaneſe, in Piedmont, in Flanders, in Switzerland, in the low countries, and in many parts of France, particularly Dauphiny, Rouſſillon, and Provence, are attended with ſome difficulties. It is to be conſidered, firſt, that the ſituation of the ground, and that of the water, muſt be ſuch as to favour the operation. Secondly; that,

that, to bear the expence of conſtructing and keeping in repair the canals, ſluices, &c. there muſt be a coalition of a certain number of perſons, through whoſe grounds the canals are to be conducted. Thirdly; that the loſs of ground is pretty conſiderable. Fourthly; (and this conſideration is of conſequence,) that much depends upon the manner in which the water is given to the plants; many gardeners having remarked that it is not ſufficient that the roots of plants ſhould be watered, but that water ſhould alſo be thrown on their leaves, which imbibe it with great eagerneſs, and are thus cleared from the duſt which choaks up their pores.

The uſe of watering-pots is not attended with the above mentioned inconveniences, but it has others which are of no leſs importance; particularly the great labour of filling the watering-pots, and carrying them to the ſpot where they are to be uſed. It is perhaps owing to this difficulty, which renders the labour and expence of watering very great, that kitchen-gardens are ſo little cultivated in our country. John Lecke, who has

written a very good differtation on watering, has computed that, in order to water properly a garden confifting of twenty beds, (each bed being fuppofed to be twenty feet long and three wide,) one thoufand feven hundred and fifty pots of water, each containing the fifth part of a common watering-pot, would be required; and that we fhould confequently be obliged to fill one watering-pot more than three hundred times: a degree of labour which appears impracticable, particularly when it is confidered that the water muft be drawn or pumped up from a well, or taken up, by dipping, from a river. As a remedy for thefe inconveniences, he propofes that only a quarter part of the ground fhall be watered on one day, which part is to have the full quantity of water. He fays, that when all the ground has been watered in this manner, we may reft for four days: thus each part will be watered once in eight days, which, he thinks, will be fufficient in the moft dry feafons. It is evident that this method is very defective; as it drowns the plants one day, and leaves them in want of water the following

feven.

ſeven. The moſt experienced gardeners agree, that watering ſhould be performed in an equal manner, and repeated regularly; otherwiſe they think it better not to water at all.

Theſe conſiderations led me to conſider what means might be ſubſtituted to thoſe already in uſe; and the firſt idea that preſented itſelf to my mind was, to make uſe of an engine; but, as that method cannot be adopted with advantage, except where the reſervoir of water is higher than the ground to be watered, I thought it would be better to contrive means for carrying about the ground ſuch a quantity of water as would render it ſeldom neceſſary to return to the place where it is procured. The diſtance between the wheels of carriages making it difficult to employ them in gardens, I tried a carriage with a ſingle wheel, and found that ſuch an one, which would only require walks of eighteen inches in breadth, would ſupport a caſk of a proper ſize; by means of which beds of ten or twelve feet wide might eaſily be watered. This carriage might be drawn by a mule, or an aſs, and

one

one man (whofe bufinefs it would be to guide the animal, to fupport the carriage in places where it might be liable to be overfet, and to open and fhut the cocks when neceffary,) would thus be able to water a great fpace of ground in a fhort time.

Many perfons have fuggefted, that making ufe of only one wheel to the carriage would caufe too great a degree of friction, and that it would be impoffible to turn the carriage, without taking up a large fpace of ground for that purpofe. This laft inconvenience would not take place, if the beds and walks of a garden were originally formed with a view to the ufe of fuch a machine; it might however be found convenient to form the carriage with two broad wheels, which fhould have only an interval of two inches between them; this would facilitate the going of the machine, and would not require above fix inches more width in the walks. Another objection, not lefs important, has been made refpecting the fluctuation of the water as it goes along. The ufual practice of water-carriers pointed out to me the remedy for this;

this; and I propoſe to have a number of planks united by bands of leather, which ſhall be fixed in the inſide of the caſk, on a level with its greateſt diameter; and which, ſwimming upon the ſurface of the water, ſhall riſe and fall with it.

It has been thought, that it would be advantageous to keep the water parallel to the axis of the caſk, (whether the carriage went up hill or down,) that the weight might never be too much increaſed either forwards or backwards. This difficulty it appears impoſſible to remove, without rendering the machine rather complicate. Of various methods which have occured to me, the moſt ſimple is, to ſupport the fore part of the caſk in a firm manner, and to let the hind part reſt in a ſemi-circle formed of ſeveral bands of iron, which, by means of a ſort of rack, (to be moved by a handle, at the will of the conductor,) might be ſo managed as to keep the water always in a line with the axis of the caſk. This might be done with great exactneſs, by the help of a level, provided thoſe who conduct the great operations of agriculture could attend to ſuch minutiæ.

The

The figures in Plate XXIII. ſhew the various ways in which ſuch a machine may be uſed, according to the different purpoſes for which it is required.

In Fig. 1. the pipes for watering, which terminate in what are called *roſes*, are all on one ſide of the caſk. The man who conducts the machine is ſuppoſed to be going to ſhut the cock.

In Fig. 2. the watering-pipes are placed behind the caſk. The machine has two wheels, to render it more convenient for turning.

In Fig. 3, a long leathern pipe, terminating in a roſe, is fixed to the caſk, inſtead of the uſual watering-pipes. The man holds the leathern pipe in one hand, and with the other directs the roſe, ſo as to throw the water wherever he wiſhes it ſhould fall.

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Fig. 1

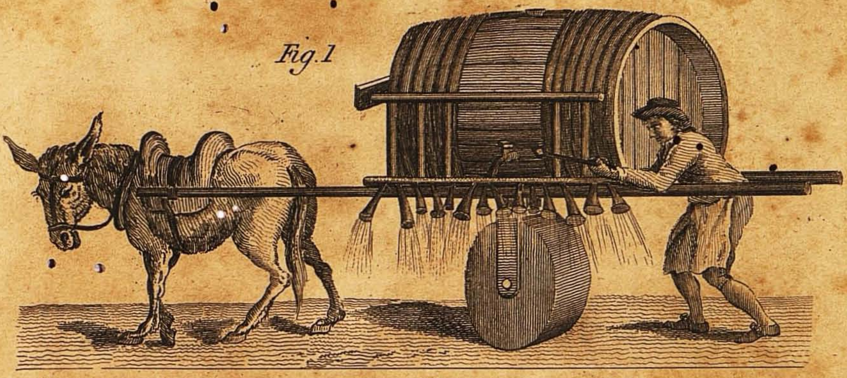
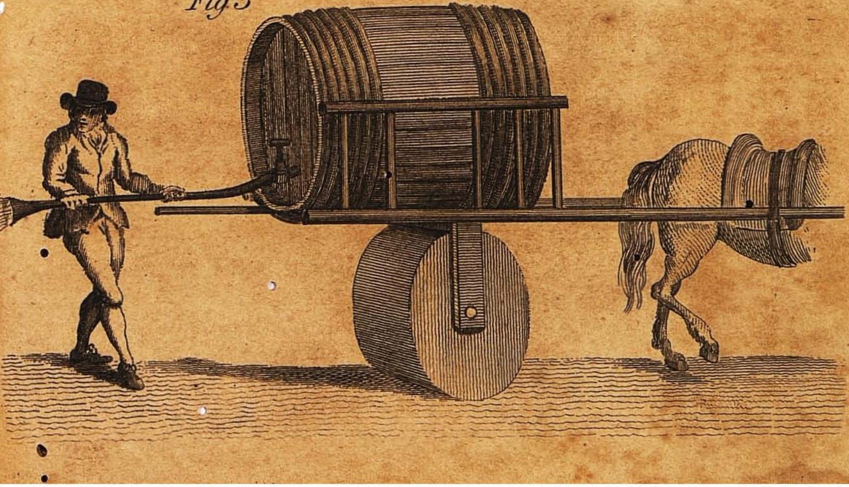


Fig. 2

Fig. 3



INDEX

TO THE

FIFTH VOLUME.

A

Page

ALKALI, on the quantity of it in different ſubſtances, 336
Alkaline ſalts, on the beſt manner of procuring them, 398
Alkaline ſubſtances, experiments on thoſe uſed in bleaching, 255. 330. 396
Anchor, patent for one on a new conſtruction, - 380
Animal ſubſtances, on their converſion into a fatty matter, 185
Antill, Edward, Eſq. On raiſing and dreſſing hemp, 384
Arches, patent for caſt-iron blocks to be uſed in them, 361
Atkinſon, Mr. John. Patent for making certain colours or paints, - - - 89

B

Baumé, M. On the purification of crude ſaltpetre, 129. 196
Bayley, Mr. Alexander Mabyn. Patent for making freſh water from ſea-water, &c. - - 320
Beaver, and beaver hats, patent for dying, - 98

Page

Beer, patent for separating it from the yeast, &c. 73

Bentham, Samuel, Esq. Patent for a new method of planing wood, - - - 293

Bernie, Mr. Samuel. Patent for preparing and restoring the calx of lead, &c. - - 230

Bleaching, patent for certain vegetable substances to be used in it, - - - 173

——— experiments on the alkaline substances used in it, - - - 255. 330. 396

——— *paper*, patent for, - - 369

Blocks, patent for cast-iron ones to be used in arches, 361

Blunt, Mr. Richard Tillyer. Patent for a composition to be used instead of yeast, - - 171

Boulard, M. On preserving those who grind colours from disorders, - - - 138

Bramah, Mr. Joseph. Patent for locks upon a new construction, - - - 217

Brass, patent for making it, - - - 24

Bread, on making it from rice, - - 350

Bridge, account of that at Wearmouth, - 364

Brine-springs, patent for a machine for making fresh water from them, - - - 320

Buchanan, Mr. Robertson. Patent for a pump for raising water, &c. - - - - 236

Buckles, elastic, patent for making, - - 19

Burdon, Rowland, Esq. Patent for cast iron blocks to be used in the construction of arches, - 361

——————— Account of Wearmouth-bridge, 364

Burgess, Thomas, Esq. Patent for a rotary motion from an alternate movement, - - 1

C

Canals, navigable, patent for constructing them without locks, - - - 11

Page

Carpenter, Mr. Elias. Patent for bleaching paper, 369
Caſt ſteel, on welding it, - - - 327
Cement for preſerving ſhips &c. patent for, - 177
Charcoal, on the heat produced by it, - 418
Cheſton, Mr. Thomas. Patent for making elaſtic ſpring-buckles and ſpurs, - - 19
Colouring-matter, of linen-yarn, experiments on, - 408
Colours, patent for making certain ones, - 89
——— on preſerving thoſe who grind them from diſorders, - - - 138
Corn, on the uſe of ſithes for reaping it, - 62

D

Dearman, Mr. Richard. Patent for making mills for grinding malt, &c. - - 247

E

Earth, patent for a method of raiſing it, &c. - 77
Emerſon, Mr. James. Patent for making braſs, 24
Engravers, deſcription of a movable table for them, 354
Engraving upon glaſs, method of, - - 279

F

Files, deſcription of a machine for cutting them, 179
Fire-engine, patent for a pump which may be converted into one, - - - 236
Fluor-acid, on its action upon ſiliceous earth, 210. 271
Frankland, Sir Thomas, Bart. On welding caſt ſteel, 327

G

Gibbes, George Smith, B. A. On the converſion of animal ſubſtances into a fatty matter, - 185

Page

Glass, method of engraving upon, - - 279

Golding, Mr. Robert. Patent for dying beaver and beaver-hats, - - - 98

Green, Mr. Joshua. Patent for constructing navigable canals without locks, - - 11

Grimshaw, Mr. John. Patent for vegetable substances to be used in clearing or bleaching cloths, 173

H

Hats, patent for dying them, - - 98

Heat, on that produced by charcoal, and charred turf, 418

Hemp, on raising and dressing it, - - 384

Henry, Mr. William. Description of a self-moving or sentinel register, - - - 32

Horse-Chesnuts, patent for extracting starch from them, 318

I

Iron, on the properties and composition of, - 45

—— specific gravity of different sorts, - 49

—— wrought or forged, properties of, - 115. 119

—— cast or raw, properties of, - - 118. 120

K

Kiln, patent for one for drying malt, &c. - 289

Kirwan, Richard, Esq. Experiments on the alkaline substances used in bleaching, - 255. 330. 396

Kitchen-gardens, on watering them, - . 423

L

Lead, calx of, patent for preparing and restoring, &c. 233

—— *white*, method of preventing injury to those who prepare it, - - - 249

Levy, Mr. Jacob. Patent for making semolina from wheat, 383

Linen-

Page

Linen-yarn, on the colouring-matter of it, - 408

Locks, patent for constructing navigable canals without them, - - - - 11

—— upon a new construction, patent for, - 217

Longhi, the Abbé Joseph. Description of a movable table for engravers, - - 354

Loom, description of one on a new construction, - 322

M

Machine for raising, removing, and delivering earth, &c. patent for, - - - 77

Malt, patent for mills for grinding it, - - 247

—— patent for a kiln for drying it, - 289

Mathew, Mr. Felton. Patent for separating the beer from yeast, and preserving the yeast, - 73

Mills for grinding malt, &c. patent for, - 247

Motion, rotary, patent for producing, from an alternate movement, - - - 1

Murray, Lord William. Patent for extracting starch from horse-chesnuts, - - - 318

N

Nicholson, Mr. William. Patent for a machine for printing on paper, linen, cotton, woollen, &c. 145

O

Oak-trees, on forming them into compass shapes, 10

Oils, remarks on their drying quality, - 281

P

Paints, patent for making certain ones, - 89

Paper, patent for bleaching it, - - 369

Pearson,

Page

Pearson, George, M. D. Experiments and obfervations on a kind of fteel called *wootz*, &c. 45. 107

Pepper, Mr. John. Patent for a kiln for drying malt or other grain, - - - 289

Planing wood, patent for a new method of, - 293

Pot and pearl afh, on the procefs of obtaining them, 406

Printing on paper, linen, cotton, woollen, &c. patent for, - - - - 145

Printing-prefs, defcription of an improved one, - 26

Pump for raifing water, patent for, - - 236

Pumping veffels, machine for, - - 38

Puymaurin, M. de. On the action of the fluor-acid upon filiceous earth, &c. - - 210. 271

R

Randall, Mr. William. On forming oak-trees into compafs fhapes, - - - 101

Regifter, felf-moving or fentinel, defcription of, - 32

Rice, on making bread from it, - - 350

Ridley, Mr. Jofeph. Defcription of an improved printing-prefs, - - - 26

Rotary motion, patent for producing, from an alternate movement, - - - 1

S

Sage, M. On the comparative heat produced by charcoal, and charred turf, - - 418

Salt, patent for a machine for making it from fea-water, &c. 320

Saltpetre, crude, on the purification of, - 129. 196

Sea-water, patent for a machine for making frefh-water from it, - - - 320

Semolina, patent for making it from wheat, - 383

Ships,

Page

Ships, patent for a cement for preserving them, - 177
—— patent for a pump for them, - - - 236
Sholl, Mr. Samuel. Description of a loom on a new construction, - - - 322
Siliceous earth, on the action of the fluor-acid upon it, 210. 271
Silks, description of a loom for weaving them, - 322
Sithes, on their use for reaping corn, - - 62
Sparrow, Mr. Joseph. Patent for a method of raising, removing, and delivering earth, water, stones, &c. 77
Spermaceti, on the conversion of animal substances into a matter resembling it, - - 185
Spring-buckles, elastic, patent for making, - 19
Spurs, elastic, patent for making, - - - 19
Starch, patent for making it from horse-chesnuts, 318
Steel, on a kind called *wootz*, - - 45
—— specific gravity of different sorts, - 49
—— properties of, - - - 116. 120
—— *cast*, on welding it, - - 327
Stones, patent for a method of raising and delivering them, 77
Stuard, Mr. James. Patent for an anchor on a new construction, - - - 380
Sylvestre, M. On watering kitchen-gardens &c. 423

T

Table, movable, for the use of engravers, description of, 354
Turf, charred, on the heat produced by it, - 418

V

Vegetable substances for clearing or bleaching cloths, patent for, - - - 173
Vessels, account of a machine for pumping them, 38

W *Ward*,

W

Page

Ward, Mr. Archer. Method of preventing injury to thoſe who prepare white-lead, - - - 249

Water, patent for a method of raiſing and delivering it, - 77

——*freſh,* patent for a machine for making it from ſea-water, &c. - - - 320

Watering kitchen-gardens, on the means of, - 423

Wearmouth account of the iron-bridge there, - 364

Wells, Mr. Richard. Account of a machine for pumping veſſels at ſea, - - - 38

Wheat, patent for making ſemolina from it, - 383

White lead, method of preventing injury to thoſe who prepare it, - - 249

Wood, patent for a new method of planing it, - 293

Worth, Mr. John. Patent for a cement for preſerving ſhips &c. - - - 177

Wootz, on a kind of ſteel ſo called, - 45. 107

—— mechanical properties of - - 47

—— ſpecific gravity of, - - - 49

—— effects of fire on, - - - 51

—— effects of fire and oxygen gaz on, - 57

—— experiments on, with diluted nitrous acid, - 58

—— experiments on, with diluted ſulphuric acid, 60

—— experiments with oxide of, - - 113

—— compared with other ſtates of iron, - 125

Y

Yarn, linen, on the colouring-matter of, - 408

Yeaſt, patent for ſeparating the beer from it, &c. - 73

—— patent for a compoſition to be uſed inſtead of it, 171

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